Acerca de este libro

Esta es una copia digital de un libro que, durante generaciones, se ha conservado en las estanterías de una biblioteca, hasta que Google ha decidido escanearlo como parte de un proyecto que pretende que sea posible descubrir en línea libros de todo el mundo.

Ha sobrevivido tantos años como para que los derechos de autor hayan expirado y el libro pase a ser de dominio público. El que un libro sea de dominio público significa que nunca ha estado protegido por derechos de autor, o bien que el período legal de estos derechos ya ha expirado. Es posible que una misma obra sea de dominio público en unos países y, sin embargo, no lo sea en otros. Los libros de dominio público son nuestras puertas hacia el pasado, suponen un patrimonio histórico, cultural y de conocimientos que, a menudo, resulta difícil de descubrir.

Todas las anotaciones, marcas y otras señales en los márgenes que estén presentes en el volumen original aparecerán también en este archivo como testimonio del largo viaje que el libro ha recorrido desde el editor hasta la biblioteca y, finalmente, hasta usted.

Normas de uso

Google se enorgullece de poder colaborar con distintas bibliotecas para digitalizar los materiales de dominio público a fin de hacerlos accesibles a todo el mundo. Los libros de dominio público son patrimonio de todos, nosotros somos sus humildes guardianes. No obstante, se trata de un trabajo caro. Por este motivo, y para poder ofrecer este recurso, hemos tomado medidas para evitar que se produzca un abuso por parte de terceros con fines comerciales, y hemos incluido restricciones técnicas sobre las solicitudes automatizadas.

Asimismo, le pedimos que:

+ *Haga un uso exclusivamente no comercial de estos archivos* Hemos diseñado la Búsqueda de libros de Google para el uso de particulares; como tal, le pedimos que utilice estos archivos con fines personales, y no comerciales.

+ *No envíe solicitudes automatizadas* Por favor, no envíe solicitudes automatizadas de ningún tipo al sistema de Google. Si está llevando a cabo una investigación sobre traducción automática, reconocimiento óptico de caracteres u otros campos para los que resulte útil disfrutar de acceso a una gran cantidad de texto, por favor, envíenos un mensaje. Fomentamos el uso de materiales de dominio público con estos propósitos y seguro que podremos ayudarle.

+ *Conserve la atribución* La filigrana de Google que verá en todos los archivos es fundamental para informar a los usuarios sobre este proyecto y ayudarles a encontrar materiales adicionales en la Búsqueda de libros de Google. Por favor, no la elimine.

+ *Manténgase siempre dentro de la legalidad* Sea cual sea el uso que haga de estos materiales, recuerde que es responsable de asegurarse de que todo lo que hace es legal. No dé por sentado que, por el hecho de que una obra se considere de dominio público para los usuarios de los Estados Unidos, lo será también para los usuarios de otros países. La legislación sobre derechos de autor varía de un país a otro, y no podemos facilitar información sobre si está permitido un uso específico de algún libro. Por favor, no suponga que la aparición de un libro en nuestro programa significa que se puede utilizar de igual manera en todo el mundo. La responsabilidad ante la infracción de los derechos de autor puede ser muy grave.

Acerca de la Búsqueda de libros de Google

El objetivo de Google consiste en organizar información procedente de todo el mundo y hacerla accesible y útil de forma universal. El programa de Búsqueda de libros de Google ayuda a los lectores a descubrir los libros de todo el mundo a la vez que ayuda a autores y editores a llegar a nuevas audiencias. Podrá realizar búsquedas en el texto completo de este libro en la web, en la página `http://books.google.com`

This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

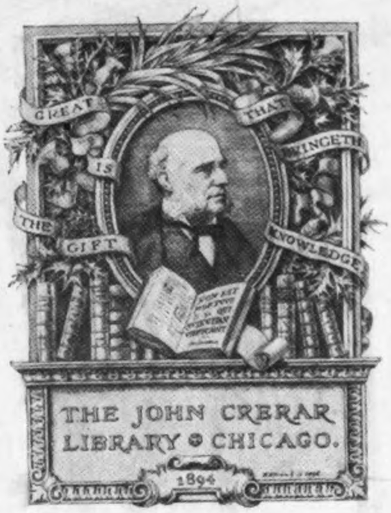
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`



THE JOHN CRERAR
LIBRARY ◦ CHICAGO.
1894

LIBRARY

AMERICAN ELECTRICIAN

A Journal of Practical Electrical and Steam Engineering

VOLUME XIII

JANUARY—DECEMBER, 1901.

American Electrician Company
Beard Building
New York

GENERAL INDEX

:eferences to Notes in "Abstracts from Foreign Contemporaries" are distinguished by an asterisk preceding the page number.
escriptions of central stations and telephone exchanges are indexed only under the respective heads, "Central" and "Telephone."

A

Accident, An odd, By O. C. Thompson.. 598
——, An unaccountable, By Wm. D. Treloar 409
Accumulator. See Storage Battery.
Alkali chlorides, Electrolysis of fused....*536
——process, Outhenin-Chalandre electrolytic *289
Allis steam engines for the Glasgow Tramways 390
Alternating-current ammeter, arc lamp, central station, diagrams, etc See Ammeter, Arc lamp, Central station, Diagrams, etc.
Alternating-current duplicate feeder system *577
—— —— terminology (Edit.).......... 584
Alternations and cycles. (Edit.).......... 180
Alternators, Parallel operation of.......... 583
—— —— ——, By A. S. McAllister..... 435
——Engine-driven, By Ralph J. Patterson 239
American Institute of Electrical Engineers, Library of the, 353; (Edit.).... 355
—— —— —— —— Annual Convention 445
American Street Railway Association Convention 531
Ammeter and socket plug, Grabosch combined, (patent) 222
——and voltmeter, Alternating-current.. *74
——, Construction of an.......... 500
——shunts and transformers for switchboard service; Machado & Roller.... 244
Arc-lamp carbon, Hachmann, (patent).. 78
—— ——carbon-holder contact, Stevens, (patent) 27
—— —— circuits, Baker regulating device for series alternating-current, (patent) 579
—— —— ——, Regulating devices for series alternating-current, By J. Henry Hallberg, 529; (Edit.).......... 540
—— ——for series circuits, Alternating-current *219
—— ——, Hackl *220
—— ——, Nernst effect.......... *24
—— ——, Rice polyphase, (patent)...... 396
—— ——trouble, High-voltage..........*174
—— ——using highly refractory electrodes *175
Arc lamps for street illumination, Relative merits of open and enclosed, By W. D'A. Ryan, 522; (Edit.).......... 541
—— ——, Photometric values of, By C. P. Matthews, 324; (Edit.).......... 354
—— ——, System of regulation for series alternating-current; Western Elec. Co.......... 94
—— ——, Warner gas check for enclosed, (patent).......... 444
Arc-light carbons, Automatic plating machine for; U. S. Carbon Co.......... 51
—— ——dynamo, Unusual action of an By E. C. Sutton.......... 46
—— —— —— troubles and their remedies, Some Brush, By F. B. O'Hanlon 596
—— ——dynamos, Rebuilding old........ 497
Arc lighting at the beginning of the Twentieth Century, By H. W. Hillman, 326; (Edit.).......... 354
—— ——practice, Modern.......... 324
—— ——problem. See Problem.
Armature torque, Formula for direct-current, (Q. & A.).......... 510
Armatures, A comparison of dynamos with surface-wound and slot-wound, By P. M. Heldt.......... 106
——, Stripped railway motor, By Frank Berry, Jr.......... 454
——, Weak fields and grounded, By Frank Berry, Jr.......... 189
Aron meter for four-wire three-phase systems *288
Australasia, Electrical progress in, By Lawrence Birks.......... 267
Automobile battery. See Storage battery.

B

Battery. See Cell and Storage battery.
——solution, Electropoion, (Q. & A.).... 510
Beissel feed-water softener.......... 576
Bell system, Return call, with one battery (Q. & A.).......... 601
Bell-wiring problem. See Problem.
Bells, Electric, on 110-volt circuits, By Ed. S. Morgan, 89; A. R. Van Volkenburgh 46
Berliner patent, The, (Edit.).......... 120
Bernard Company at the Pan-American Exposition, The..........Adv. 35, Sept.
Blow-out for railway controllers, Magnetic *114
Boats, Submarine 293
Boiler construction, Radical departure in.*534
——economy, A practical demonstration in, By C. Watson.......... 505
——feeding and feed-water heating, By L. B. Mather.......... 67
——furnace performance, (Edit.).......... 498
——, Modern horizontal tubular.......... 102
——room, Central station, By William D. Ennis 327
—— ——efficiencies, By W. D. Ennis... 388
—— ——practice (Edit.).......... 226
——scale. See Scale.
——troubles, A few common, By R. A. Douglass 265
Boilers and engines for superheated steam*395
——, Effect of scale in.......... 495
——, Makins' attachment for improving circulation in..........*534
——, Relation of the rate of evaporation to the fuel economy of, By William D. Ennis 521
——, The use of zinc in, By R. A. Douglass 572

BOOKS, NEW:
A B C of the Telephone. James E. Homans 447
American Street Railway Investments. Street Railway Publishing Company.. 292
Annual Report of the Board of Regents of the Smithsonian Institution. Government Printing Office.......... 496
Central Station Experiences. Power Publishing Company 398
Copper Handbook, The. Horace J. Stevens 178
Design and Construction of Oil Engines. A. H. Goldingham.......... 118
Electric Gas Lighting. H. S. Norrie,
Electric Lighting. Francis B. Crocker.. 223
Electrical Designs. American Electrician Company 561
Electrical Engineers' Pocket-Book. Horatio A. Foster..........Adv. 35, Dec.
Electrical Units for Boys. Arthur A. Kent 28
Electricity Made Simple, Clark Caryl Haskins 561
Electrochemistry, Outlines of. Prof. H. C. Jones ....Adv. 35, Dec.
Electromagnets; Their Design and Construction. A. N. Mansfield.......... 561
Elements of Electrical Engineering. Charles Proteus Steinmetz.......... 398
Engine Tests. Geo. W. Barrus, S. B.. 28
"Engineering" and Electric Traction Pocket Book, The. Philip Dawson.... 496
Handbook on Engineering. Henry C. Tulley 223
High Speed Steam Engines. Wm. Norris and Ben. H. Morgan.......... 28
Induction Coils. H. S. Norrie.......... 292
Induction Motor, The. B. A. Behrend.. 398
International Association of Municipal Electricians, Report of the Fifth Annual Convention of the.......... 118
Inventor's Manual. Norman W. Henley & Co. 223
Machinists' and Draftsmen's Handbook. P. Lobben 118
Mechanical Drawing and Elementary Machine Design. John S. and David Reid 78
National Electric Light Association, Twenty-Third Convention of the....... 118
Progress of Invention in the Nineteenth Century, The. Edward W. Byrn...... 178
Saw Filing. Robert Grimshaw.......... 352
School Chemistry, A. John Waddell, B. A. 447
Telephone Lines and Their Properties. William J. Hopkins.......... 292
Telephones Furnished by the United States Signal Corps, Instructions for using. Capt. Samuel Reber.......... 352
Universal Electrical Directory, The. J. A. Berly's; H. Alabaster, Gatehouse & Co. 223
Booster, An Improvised, By Ed. S. Morgan, 47; C. C. Webster, 186; H. P. Wood, 186; E. W. Lothrop.......... 239
Boosters, Improvised, By Walter M. Hollis 524
——and storage batteries, (Diagrams).. 196
——, Storage batteries controlled by reversible *442
Brake dynamometer. See Prony Brake.
——electromagnets, Direct-current *288
——, Lindstrom electric elevator, (patent) 444
Bronze varnish, A recipe for.......... 224
Brush arc-light dynamo troubles and their remedies, Some, By F. B. O'Hanlon 596
——motor, An old-time, By A. B. Weeks 573
Brushes, Increasing the life of copper... 497
——, Rohrer connection for carbon, (patent) 77
Brush-holder, Kragh, (patent).......... 117
——, Pomeroy, (patent).......... 221
Bryan-Marsh comparimeter.......... 50
Bucking of railway generators, By Eugene C. Parham, 86, 408; Geo. W. Malcolm, 135; Ed. S. Morgan.......... 240
Buffalo terminal transformer station of the Cataract Power and Conduit Company, By Fred P. Woodbury.... 385
Bulkhead doors, Electrically controlled, By George E. Walsh.......... 218

C

Cable carriers, Telephone, By W. S. Henry 408
——for three-phase currents, Esson, (patent) 538
Caldwell electrolytic interrupter..........*288
Calibrating a voltmeter, A simple method of, By J. Rowland Brown.......... 573
Calorimeter, Barrel, By Chas. L. Hubbard 503
——, New form of Goodman steam.......*78
——Separator, By Chas. L. Hubbard.... 591
C & C series-parallel system of control for printing-press motors.......... 50
Candle-power of incandescent lamps. Standard. By Joel Gomborow, 403; G. E. Rosenfield, 455 (Edit.).......... 294
Carbon, Arc-lamp (patent).......... 78
——brushes. See Brushes.
Carbons, Automatic plating machine for arc-light; United States Carbon Co. 51
Cataract Power and Conduit Company, The new Buffalo terminal transformer station of the, By Fred. P. Woodbury 385
Catechism, Electrical..........
48, 90, 137, 194, 241, 311, 364, 410, 457, 509, 551, 600
Cell, Commelin-Viau gas..........*349
——, Electrolytic alkali..........*220
——, German Imperial electrical standard *395
——, Haas & Oettel hypochlorite........*395
——, Hussey bisulphate of mercury...... 366
——, New carbon-zinc *577
Cells and batteries in the Royal Navy, Testing *175
Central station, Boston Edison. By Alton D. Adams, 268; (Edit.).......... 295
—— ——, Brooklyn Edison, 1; New Westinghouse engines for 108
—— ——, Consolidated Electric Light & Power Co., By J. R. Williams...... 421
—— ——, Georgia Electric Light Company, 465; (Edit.).......... 496
—— ——, Glasgow 13
—— ——, Gloucester 12
—— ——, Hoboken, 278; (Edit.).......... 295
—— ——, Santa Monica, Cal., By J. R. Cravath, 251; (Edit.) 294
—— ——, Urbana, Ill., By W. H. Zimmerman 482
—— ——, Wallsend-on-Tyne, 377; (Edit.) 400
—— ——, Wappinger's Falls, N. Y., By C. W. Obert, 565; (Edit.).......... 584
—— ——, West Ham.......... 9
Central station boiler room, By William D. Ennis. 327
—— ——, Hints on laying out a........ 495
—— ——methods, By S. T. Webber.... 550
—— ——working, A point in.......... 29
——stations, American and English, (Edit.) 80
—— ——, Charging in, By Ralph J. Patterson 185
—— ——, Coal handling machinery, for, By F. L. Hutchinson.......... 496

—— ——, Electrical service in........... *26
—— ——, German, ... 581
—— ——, Small, (Edit.) 584
Chicago Electrical Association; Election of officers 79
Chimneys for power stations, Brick, By W. D. Ennis................................ 570
Chlorides, Electrolysis of fused alkali..*536
Chlorine, Electrolytic production of soda and, By Ernest Franke............... 104
Circuit breaker, Scott motor starter and, (patent) 28
Circuits, Resistance of simple and complex, (Lessons) 507
Circulation in boilers, Makins' method of improving *534
Clarke Automatic coal-weighing scales... 511
Clarke Automatic Telephone Company's system 141
Clearance and compression in steam engines *219
Clutches, Group-driven lathes with electromagnetic *76
Coal burning internal-combustion engine..*491
——handling machinery for central stations, By F. L. Hutchinson........... 486
Commelin-Viau gas battery cell............ *349
Commutator clamps, Geisenhöner, (patent) 495
—— connections for reducing voltage one-half (Q. & A.).............................. 411
——, Priest and Schermerhorn, (patent). 118
——, Repairing and connecting up a, By A. B. Weeks.................................... 187
——, Thomson anti-sparking, (patent).... 222
Comparimeter, Bryan-Marsh 50
Condensation, Water of, By C. W. Obert 187, 235
Condensing, Exhaust steam heating vs., By A. M. Earl.................................. 89
Conductors, A simple method of locating a short circuit between electrical, By Arthur R. Roe........................... 208
Conduit, Bathurst interior, (patent)...... 493
——, New railway.................................*175
——wiring, Alternating-current, By C. R. James 599
Connections, Problem in, See Problem
Connectors and fuses, Cable...............*493
Control. See also Regulation.
——, Electric railway car, (Edit.)........ 31
——for printing-press motors, C & C series-parallel system of.............. 50
——of lights from more than one point, By Francis M. Appleton.............. 47
——, Parham method of railway motor, (patent) 351
Controller at the Pan-American Exposition, Cutler-Hammer solenoidal electrical elevator 459
——, Stull, (patent).............................. 177
——, Wiring diagram for K2.............. 92
Controllers, Garrett contact finger for motor, (patent) 222
——, The care of street railway, By Frank Berry, Jr.............................. 596
Converters, Berg distribution system for (patent) 27
——, Lamme safety system for, (patent) 351
——, Rotary, By A. S. McAllister......... 568
——, Starting, By Arthur B. Weeks...... 358
——, Three-wire distribution from, By Chas. N. Black.............................. 550
Cooling towers, Commercial forms of, By C. W. Obert.................................. 475
—— ——, Stocker fanless,................ 412
—— ——, The use of, By B. Franklin Hart 474
Corliss valve gear and valve setting, By C. C. Major.................................. 230
Coulomb, Charles Augustin de........... 353
Coupling. See Clutch.
Current, A mysterious, 119; F. O. Broili, 308; H. Stanley Carr, 193; George T. Hanchett 192
Curve forms on measuring instruments, The influence of.............................*221
Curves for showing the charge remaining in a storage battery........................ 436
——of direct-current dynamos to parallel operation, Relation of characteristic, By Alton D. Adams............ 68
Cutler-Hammer solenoidal electric elevator controller at the Pan-American Exposition 459
Cycles, Alternations and, (Edit.).......... 180
Cylinder cutting, Engine, By A. M. Earl.. 408
——proportions, Steam engine............*491

D

De Laval steam turbine........................ 553
Deri alternating-current motor.............*493
DESIGNS FOR APPARATUS:
  Dynamo, Electroplating, 400-ampere, By Cecil P. Poole................................ 356
  ——, Incandescent, By Cecil P. Poole; 35-light, 450; 75-light.......................... 32
  ——, Sparking, for gas-engine service... 32
  Electrodynamometer, By S. M. Kintner 228
  Fan motor, Direct-current................... 182
  Gas engine, 1-h.p., By J. C. Brocksmith 586
  Indicator, Current and potential......... 500
  Intercommunicating telephone set........ 122
  Motor, 3-h.p. launch, By Cecil P. Poole. 542
  Photometer, A simple........................ 296
  Time signal apparatus, Simple, By S. M. Kintner 402
Desrumaux feed-water softener............ 576
Diagrams, Alternating-current, (Lessons) 87
——of electrical connections: Boosters and storage batteries, 195; K2 Controller 92
——of telephone systems, By H. S. Webb 409
Diesel oil engine.................................*221
Dimmer for incandescent lamps............*442
Direct-current vs. polyphase currents...... *26
Distribution from Sterling incandescent lamps 513
——, Berg system of, for rotary converters (patent) 27
——, Hewlett alternating-current system of, (patent).............................. 27
——, Kent system of electrical, (patent). 177
Dixon Crucible Company, Power plant of the Joseph 517
Dowsing luminous electric radiators...... *24
Draw-bar pull, Formula for, (Q & A.).... 196
Duty of a pumping engine (Q & A)........ 242
Dynamo, Arc-light, Unusual action of an, By E. C. Sutton........................... 46
——, Brush arc-light, troubles and their remedies, Some, By F. B. O'Hanlon 596
——, Design for a 400-ampere electroplating, By Cecil P. Poole................... 356
——, Design for a 35-light incandescent, By Cecil P. Poole, 450; 75-light design, 32
——, Direct-current, of the Elec. Const. Co., Wolverhampton...................*492
——, Effect of reversing a field coil on a multipolar, By B. Graham........... 90
——field magnet structure, Lamme revolving, (patent) 176
——for gas-engine service, A sparking... 82
——, Midget; Elbridge Electrical Mfg. Co. 197
——, Paralleling of a direct-connected and a belted, By John M. Schmidt.. 192
Dynamos and motors, The rating and speed of, (Edit.).......................... 227
——, Bucking of railway, By E. C. Parham, 86 and 408; Geo. W. Malcolm, 135; Ed. S. Morgan....................... 240
——, Heath three-wire system of, (patent) 494
——, Induction motors as.................. *26
——operated in parallel, Compound, By Geo. W. Malcolm.......................... 135
—— —— ——, Direct-current, By Alton D. Adams.................................... 237
—— —— ——, Starting and stopping direct-current, By Alton D. Adams. 37
——, Rebuilding old arc.................... 497
——with surface-wound and slot-wound armatures, A comparison of, By P. M. Heldt 106

E

Econometer, The, By A. Bement........... 484
Economy, A practical demonstration in boiler, By C. Watson...................... 505
——, Efficiency and, (Edit.)................. 449
——in steam production, By C. W. Obert 217
Effect of scale in boilers..................... 495
Efficiencies, Boiler room, by W. D. Ennis 388
Efficiency. See also Gas and Steam engine efficiency.
——and economy (Edit.)...................... 449
—— —— operation of water wheels (Edit) 585
——of telephone generators, By W. S. Henry 453
Electrical progress in Australasia, By Lawrence Birks 267
Electricity in coal mining in the Pittsburg District, By Wm. G. Irwin......... 255
——in the nineteenth and twentieth centuries, By A. E. Kennelly............ 14
Electrocution (Edit.) 400
Electrode, New form of platinum........*537
Electrodes and terminals, Polarity of (Edit.) 499
Electrodynamometer, Adjusting an, By P. M. Gallo................................... 240
——, Construction of an, By S. M. Kintner 228
——, Note on the use of the, By Fred P. Woodbury 107
Electrolysis of fused alkali chlorides......*536
Electrolyte for bichromate of potash battery (Q. & A.)............................ 510
Electrolytic alkali cell........................*220
——alkali process, Outhenin-Chalandre..*289
——production of soda and chlorine, By Ernest Franke 104
Electromagnetic couplings, Group-driven lathes with *76
Electromagnetism (Lessons) 548
Electromagnets and solenoids, 155; Windings for 209
——, Lifting, By E. B. Clark.............. 64
Electroplating dynamo, Design for a 400-ampere, By Cecil P. Poole............. 356
Electropoion battery solution (Q. & A.).. 510
Elevator controller at the Exposition, Cutler-Hammer solenoidal electric... 459
—— ——, Lindstrom electric, (patent).. 444
Emerson fan motors, Efficiency of........ 367
Engine. See also Gas and Steam engine.
Engine Builders' Association............... 23
——, Coal burning internal-combustion..*491
——, Duty of a pumping, (Q. & A.)..... 242
Engines for superheated steam, Boilers and *395
Engineer, The new chief, By E. D. Williams 478
Engineers, A hint for practical, By William D. Ennis................................. 264
——, A short talk to, (Edit.)............... 296
English central stations, Recent types of. 9
Eureka telephone switchboard............. 140
Evaporation, Relation of the rate of, to the fuel economy of boilers, By William D. Ennis.................................. 521
Exposition. See Pan-American and South Carolina.

F

Factory power plant of the Dixon Co.. 617
—— —— ——, of the Wetmore Tobacco Co. By F. E. Bausch................ 61
Fan motor, Design for a direct-current.. 182
——motors, Comparative testing of, By S. D. Gilbert, 307; By A. R. Everest. 366
—— ——, Efficiency of Emerson......... 367
—— —— for 1901 158
Feeder system, Duplicate *577
Feed-water heater *174
——heating, Boiler feeding and, By L. B. Mather, 67; (Edit.)................. 81
—— softeners, Two English boiler...... 576
Ferranti central station at West Ham.... 9
Field coil on a multipolar dynamo, Effect of reversing a, By B. Graham....... 90
——magnet structure, Lamme revolving, (patent) 176
Fields and grounded armatures in railway motors, Weak, By Frank Berry, Jr. 189
Five-wire distribution system..............*174
Flue cleaners, Steam, By James F. Hobart 86
Fly-wheel accidents, By C. W. Obert..... 181
Formulas (Q. & A.) Direct-current armature torque 510
  Draw-bar pull 196
  Horse-power of a three-phase motor 552
  Inductance of a coil 365
  Photometer scale 138
  Size of iron resistance 552
  Storage battery pasted plate 365
Fort Wayne shell-type transformer....... 142
French Corliss-type steam engine, A...... 214
Frequency, Alternating-current, (Edit.).. 499
——changer; Stanley Electric Mfg. Co.. 243
——indicator, Alternating-current........*175
——meter, A *174
Fuel economy of boilers, Relation of the rate of evaporation to the, By William D. Ennis.................................. 521
——, Loss in economy by the incomplete combustion of, By A. Bement, 484; (Edit.) 498
——, Pulverized, By R. A. Douglass, 434; (Edit.) 449
Furnace, New electric.........................*493
——performance, Boiler, (Edit.).......... 498
Fuse box, Lyons reserve, (patent).......... 177
——, Feuerlein enclosed, (patent)......... 117
——holder, Linton combined switch and, (patent) 444
Fuses, Cable connectors and................*493

G

Galvanometer shunts *536
Ganz three-phase motors for the London Metropolitan Underground Railway.*173
Gas analyzing apparatus, By A. Bement, 484; (Edit.) 498
Gas engine efficiency tests................... 329
—— ——, Design for a 1-h.p., By J. C. Brocksmith 586
—— ——, Heat waste of a, (Edit.) 180; By Philip K. Stearn 292
—— ——, Koerting 350-h.p. two-cycle... *75
—— ——, "Modern" 61
—— ——, using producer gas, Test of a large *116
Gehre meter for measuring steam delivery *116
Generators. See Alternators and Dynamos.
General Electric self-starting single-phase motor 608
Glasgow tramways, Allis engines for the 390
Gloves, Insulation resistance of wiremen's *349
Goodman steam calorimeter, New form of *76
Gould railway car lighting system.......... 313
Governor, Hartung engine.................... 13
——, Modern forms of shaft, By H. F. Schmidt 545
——, Pelton electric relay water wheel.. 604
——, Whitehead steam-engine, ...*578
Gramme, Zenobie Theophile 119
Grid. See Storage battery plate.

H

Haas & Oettel hypochlorite cell............*395
Hackl arc lamp...................................*220
Halsey homopolar motor meter............ 460
Hartmann & Braun astatic wattmeter.... *27
Hartung engine governor..................... 13
Heat waste of a gas engine, (Edit.) 180; Philip K. Stearn 292
——wastes, Neglected, By R. A. Douglass 520
Heater. See Feed-water heater.
Heating. See Steam heating.
Helios and Schuckert surface contact railway systems *25
High-tension line wires, Distance apart of, (Q. & A.)................................. 510
Horse-power of a three-phase motor, Formula for, (Q. & A.)....................... 552
——table, Electrical..............Adv. 37, Oct.
Hughes telegraph keyboard, Modification of the *173
Hunting, Buck method for preventing, (patent) 223
Hussey bisulphate of mercury cell........ 366
Huyette quick-closing water gauge...... 243
Hypochlorite cell, Haas & Oettel.........*395

L531.551

5

77505

I

Incandescent lamps for street lighting, Reflector, ... *24
—— ——, Standard candle-power of, By Joel Gomborow, 408; G. E. Rosenfield, 455; (Edit.) 294
—— ——, Symmetrical distribution from Sterling, ... 513
——sign lamps, Eckl protector for, (patent) 177
Independent telephone convention, The, 344; (Edit.) 355
Indicator, Alternating-current frequency. *175
——, Construction of a current and potential, ... 500
——diagrams, Irregular, By Elmer K. Swift 90
——, Storer magnetic speed, (patent)... 538
Inductance and reactance (Edit.).......... 31
——of a coil, Formula for, (Q. & A.).... 365
Induction coil and condenser for ⅝-in. spark (Q. & A.).......... 312
——meter, Siemens & Halske, ... *534
——motor armature or rotor, Action of an, (Lessons) 190
—— ——, Deri, ... *493
—— ——, Effect of self-induction in the rotor of an, (Lessons).......... 238
—— ——, General Electric self-starting single-phase, ... 603
—— ——, Stator of an, (Lessons).......... 307
Induction motors, Slip in, ... *289
—— ——, Three-phase, Starting.......... *579
Industrial plants, Electrical equipment in, (Edit.) 180
Injectors for boiler feeding.......... 41
Instrument for measuring the permeability of iron and steel.......... *443
——shunts and transformers for switchboard service; Machado & Roller.. 244
Instruments having magnets, Measuring, *394
——, Improved permanent-magnet measuring, By Caryl D. Haskins.......... 508
——, Influence of curve forms on measuring, ... *221
Insulation resistance of wiremen's gloves *349
——test *175
——testing device, Kitsee, (patent).......... 538
—— ——, Points on, By Fred P. Woodbury 34
Insulating varnish *220
Insulator, Hemingray line wire, (patent) 579
—— knob (patent).......... 27
Intercommunicating telephone set, Construction of an, ... 122
Interior wiring, By Charles E. Knox. Lighting of a department store, 126; Wiring of a large hotel,.......... 184
—— ——, Bathurst, patent).......... 494
—— ——, Laying out, By Geo. W. Malcolm 508
—— ——; Direct-current feeders and mains 592
Interrupter, Caldwell electrolytic.......... *288
——, Improved Simon, ... *350
——, Wehnelt, A new.......... *173
—— ——, Simple modification of the... *74
Iron and steel, Instrument for measuring the permeability of, ... *443

K

Kalamazoo Valley Electric Company, Transmission plant and sub-stations of, ... 321
Kinks, Some handy, ... 83
Knob, Insulating, (patent).......... 27
Knowledge, Short cuts to, (Edit.).......... 295
Koerting 350-h.p. two-cycle gas engine.... *75

L

Laboratory, A co-operating circulating library and electrical, ... 79
Lahmeyer motor-generator *535
Lamp. See Arc lamp, Incandescent lamp and Nernst lamp.
Lamp socket. See Socket.
Lane & Bodley Twentieth Century engine 367
Leonard motor starter patent.......... 314
Lessons in Practical Electricity:
  Action of an induction motor armature or rotor 190
  Alternating-current diagrams 87
  Effect of self-induction in the rotor of an induction motor.......... 238
  Electromagnetism 548
  Fundamental principles 454
  Magnetizing power of a coil.......... 596
  Resistance of simple and complex circuits 507
  Rotary magnetic field, The, ... 132
  Stator of an induction motor.......... 307
  Synchronous motor 362
  —— ——, Phase relations in the,...... 407
  Transformer connections 44
Library and electrical laboratory, A co-operating circulating, ... 79
Light, The reflection of, ... 179
Lighting. See also Arc lighting and Street lighting.
——and steam heating plant, A combined electric, By W. N. Zurfluh.... 201
——system for telephone booths, Lister automatic, (patent).......... 580
—— ——, Gould railway car.......... 313
Lightning arrester and self-restoring telephone switchboard drop; Phoenix Elec. Tel. Co.......... 139
——flashes, Current intensity of, ... *174
Line construction (Edit.).......... 121
——wires, Distance apart of transmission, (Q. & A.).......... 510
Locomotive, The "dummy," (Edit.).......... 449
Locomotives, Electric vs, steam, ... *26

M

Machado & Roller ammeter shunts and transformers for switchboard service 244
Machine shop service, Motors for, ... *25
Magnet. See Electromagnet and Field magnet.
——windings (Edit.) 121
Magnetic blow-out for railway controllers *114
——field, The rotary, (Lessons).......... 132
Magnetizing power of a coil (Lessons).... 597
Makins' method for improved circulation in boilers *534
Manhattan Elevated, Westinghouse transformers for the, ... 197
Mather & Platt motor-driven feed pump.. *219
Max storage battery cell.......... *578
McCormick turbines in Walla Walla plant 603
Measurements, Alternating-current, ... *350
——, Photometric, By F. Everett Lindsey 408
Measuring instruments. See Instruments.
Measuring power in alternating-current circuits, Method of, ... *115
——speed variation *442
——steam delivery, Gehre meter for, ... *116
——the permeability of iron and steel, Instrument for, ... *443
——the vibration of a transmitter diaphragm, Method of, By W. L. Merrill 67
—— voltage drop in transformers.......... *577
Mechanics, A problem in, See Problem.
Meter, A frequency, ... *174
——for four-wire three-phase systems, Aron, ... *288
——for measuring steam delivery, Gehre, *116
——, Halsey homopolar motor, ... 460
——, Small direct-current, ... *350
——, Siemens & Halske induction,.......... *534
——standards, German Imperial electrical, ... *395
——, Haskins storage battery, (patent) 77
Meters at New Orleans, Testing consumers', ... 299
——on artificial loads, Testing alternating-current, ... *114
Method of locating a short circuit between electrical conductors, By Arthur R. Roe 208
——of obtaining two three-phase secondary voltages, Simple, 339; O. A. Honnold 409
Metropolitan selective signaling system for telephone party lines.......... 511
Metropolitan Underground Railway, Three-phase motors for the London, *173
Mica lagging for steam boilers and pipes *176
Midget dynamo; Elbridge Elec'l Mfg. Co. 197
Misinformation, Electrical, (Edit.).......... 401
"Modern" gas engine 51
Motive wonder, Another, By A. A. Deighton 456
Motor. See also Fan motor, Induction motor, Railway motor and Synchronous motor.
Motor, An old-time Brush, By A. B. Weeks 575
——casing, Eck, (patent).......... 223
——, Deri alternating-current, ... *493
——, Design for a 3-h.p. launch,. By Cecil P. Poole 542
——driven feed pump, Mather & Platt,. *219
——, Formula for horse-power of a three-phase, (Q. & A.).......... 552
——generator, Lahmeyer, ... *535
——, Johnson variable-speed, (patent).... 176
——starter and circuit-breaker, Scott, (patent) 28
——starter patent, Leonard 314
——starting rheostat, Hewlett, (patent). 117
—— ——and speed-regulating device, Kragh, (patent) 589
——testing without a dynamometer..... *501
Motors, Alternating vs. direct-current, (Edit.) 448
——in Brooklyn Navy Yard shops, Thresher direct-current,.......... 602
——, C & C series-parallel system of control for printing-press, ... 50
—— and dynamos, Rating of enclosed, (Edit.) 585
——for machine shop service.......... *25
——, Sparkless disconnection of shunt,.. *348
——, Speed regulation of shunt-wound,.. *442
——, Tests of single-phase Wagner, ... 94
——, The rating and speed of dynamos and, (Edit.) 227
——, Warner starting winding for electric, (patent) 351
Multiple-unit railway system. See Railway.
Municipal lighting plant at Wappinger's Falls, N. Y., By C. W. Obert, 565; (Edit.) 584

N

National Electric Light Association, Niagara convention of the, 330; (Edit.).... 355
Navy Yard shops, Brooklyn, Thresher direct-current motors in,.......... 602
Nernst effect, Arc lamp with a,.......... *24
——lamp (Edit.) 540
—— ——glowers, The behavior of, ... *76
—— ——heater *349
—— ——in America, Development of the, By Alexander J. Wurts.......... 437
—— ——starter, Kitsee, (patent).......... 396
—— ——, Wurts multiple, (patent)..... 291
——lamps, Commercial, ... *115
New Apparatus and Appliances:
  Acme portable testing set; Queen & Co. 246
  Adjuster, Cord. See Cord adjuster.
  Alarm column, Clark-regulator, ... 316
——, Crane blow-off valve and low water, ... 95
——, Wright high and low-water, ... 415
American Electric single-pole telephone lighting arrester and fuse block...... 146
Arc lamp and color screens for stage illumination; Baker & Fox.......... 463
—— ——, Enclosed, for series alternating-current circuits, General Incand. Arc Lt. Co. 52
—— ——, ——, Lea-Hooven. 53
—— ——, ——, National, ... 96
——lamps, "L-H" enclosed; Anderson Tool Co. 607
Automobile, Crest gasoline, ... 98
——, Olds gasoline runabout, ... 147
Baker & Fox arc lamp and color screens for stage illumination 463
Barron telephone line appliances.......... 315
Battery, "Clover Leaf" test; Elmer G. Willyoung 96
Baum separators 464
Bell, Holtzer-Cabot telephone extension, 143
Boiler tube cleaner. See Tube cleaner.
Bordo plug valve 97
Brewster sign-lamp receptacle; Electric Motor & Equipment Co. 249
Bullock machine tool motor, 52; motor driving bending rolls 247
Butman boiler flue-cleaner rod; James McCrea & Co. 414
Cable testing outfit, Fisher; Jas. G. Biddle 415
Central Telephone & Elec. Co. outfits, 373; Wall telephone set.......... 147
Century interior telephone system....... 320
Clamp, Climax steam joint; James McCrea & Co. 54
Clayton & Lambert alcohol and gasoline torches 247
Gasoline torches, 413; Pocket torches.... 372
Climax steam joint clamp; James McCrea & Co. 54
Climbers; Smith & Hemenway 198
Comead incandescent lighting outfit...... 319
Commercial Elec. Co. engine-lathe motors, 245; semi-enclosed generator....... 55
Condenser at the Pan-American Exposition, "Wheeler-Admiralty" surface,.. 374
Conduit, Flexduct; Osburn Flexible Conduit Co. 607
——, Richmondt electrogalvanized....... 54
Cooling towers, Wheeler enclosed natural-draft, ... 199
Cord adjuster, Webster, ... 375
Couch & Seeley combined telephone jack and tubular drop 144
Crane blow-off valve and low water alarm 95
Crane, Franklin portable, ... 374
Crest motor tricycle 98
Croslen reducing valve 414
Cutler-Hammer motor starter.......... 317
D. & W. telephone protector.......... 144
D'Arsonval galvanometer, "P. T.;" Elmer G. Willyoung.......... 96
Darling gate valve 249
De Veau switchless intercommunicating system; Stanley & Patterson.......... 148
Direct-current motor. See Motor.
Dynamo, Franklin; Parsell & Weed.... 53
——, Thresher, direct-connected to Stilwell-Bierce turbine 250
Dynamos and motors; Reliance Electric Co. 605
——, Semi-enclosed; Commercial Elec-Co 55
——, Sturtevant eight-pole, ... 462
Eck motor 607
Edison battery fan motor outfit Adv. 81, June
Elgin adjustable pipe wrench; Western Elec. Co. 56
Emerson direct-current power motors.... 199
Engine. See Gas engine, Oil engine, or Steam engine.
Ericsson hotel telephone equipments.... 248
Evershed ohmmeter; Queen & Co. 413
Exhaust head, Sims steam, ... 463
Fan motor outfit, Edison battery Adv. 81, June
Faradmeter; Elmer G. Willyoung...... 514
Faries parabolic adjustable reflector.... 605
Farr bridging telephone outfit.......... 147
Feed-water heater, Hoppes, ... 555
—— ——heaters, New attachment for Hoppes 606
Filter, "White Star" oil; Pittsburgh Gage & Supply Co. 316
Fire alarm and police signal phone, Yurgae, ... 463
Fisher cable testing outfit; Jas. G. Biddle 415
Fixture block, Roberts, ... 198
Flasher for illuminated signs; Reynolds Electric Co.......... 606
Flashlight, Roche incandescent, ... 557
Foote-Pierson main-line telegraph sounder 98
Franklin dynamo; Parsell & Weed...... 53
Franklin portable crane 374
Fuse block, Single-pole telephone lightning arrester and; American Elec. Fuse Co. 146
——carrier, General Incandescent panel board with removable enclosed, ... 515
Galvanic metal rod packing 373
Galvanometer, "P. T." D'Arsonval; Elmer G. Willyoung 96
Garton-Daniels telephone extension circuit apparatus 146
Gas and gasoline engine, Maywood...... 608
—— engines, Roche igniter for.......... 374
Gasket, Gilbert's self-packing water gauge; Quaker City Rubber Co........ 557

New Apparatus, continued:
Gasoline motor, Palmer marine, ... 198
——torches. See Torches.
——tricycle, Crest, ... 98
Gear-cutting and milling attachment for lathes, Universal; Seneca Falls Mfg. Co. 372
General Incandescent electro-mechanical switch, 247; Enclosed arc lamps for series alternating-current circuits, 52; Panel board with removable enclosed fuse carrier 515
Generating set, Sturtevant, ... 245
Gilbert self-packing water gauge gasket; 557
Governor, Replogle relay-returning water-wheel, ... 56
Haines & Noyes 30-drop desk telephone switchboard 144
Halsey direct-current meter 514
Hart "Diamond H" flush switches, 320; Automatic door switch 556
Heating apparatus, Sturtevant hot-blast, 97
Holtzer-Cabot enclosed motors, 556; Telephone exchange motor-dynamo, 55; Telephone extension bell 143
Hoppes feed-water heater.................. 555
—— —— ——, New attachment for.. 606
Hubbell chain pull socket.................. 463
Igniter for explosion engines, Roche,.... 374
Incandescent flashlight, Roche, ... 557
——lamp, Lowatt reflector; Western Elec'l Supply Co. 373
—— ——replacer, Bulb cleaner and; Incand. Elec. Light Manipulator Co.... 516
——lighting outfit, Comead pocket,...... 319
Instruments, Willyoung portable testing, 96, 514
Interior telephone system; Century Tel. Co. 320
Keelyn receiver and transmitter.......... 148
Kellogg telephone transmitter............ 555
Kinsman reflectors; McLeod, Ward & Co. 557
Kuhlman transformer construction Adv. 35, Sept.
Lathes, "Star" screw-cutting engine, 199; Universal gear-cutting and milling attachment for; Seneca Falls Mfg. Co.... 372
Lea-Hooven enclosed arc lamps......... 53
Lightning arrester and fuse block, Single-pole; American Electric Fuse Co.. 146
Lowatt reflector incandescent lamp; Western Electrical Supply Co.......... 373
Lundell motor, Sprague Electric Company; Enclosed medium-speed, 318; In surgical operations 516
McCormick turbine driving mining machinery; at Boston & Montana mine, 415; at Comstock mine 516
Magneto. See Telephone magneto.
Marshall-Sanders three-ampere snap switch, 464; Plug and receptable........ 555
Maywood gas and gasoline engine........ 608
Meter, Halsey direct-current, ... 514
Mianus telephone outfit.................... 147
Midget plug and receptacle, Marshall-Sanders, ... 555
Mietz & Weiss oil engine in a residential lighting plant 315
Milling and gear-cutting attachment for lathes; Seneca Falls Mfg. Co.......... 372
Motor. See also Gasoline motor.
——and air compressor, Triumph, ... 55
——and regulator, Paragon sewing machine, ... 414
——, Bullock machine-tool, ... 52
—— driving bend rolls, Bullock.......... 247
——, Eck 607
——, Emerson direct-current power, .. 199
——, Lundell medium-speed; Sprague Elec. Co. 318
——, Palmer marine, ... 198
——, Palmer & Olson enclosed, ... 200
——starter, Cutler-Hammer, ... 317
Motor-dynamo, Holtzer-Cabot telephone exchange, ... 55
Motors and generators, Sturtevant eight-pole, ... 462
——, Commercial engine-lathe, ... 245
——, Holtzer-Cabot enclosed, ... 556
——in surgical operations, Lundell; Sprague Elec. Co. 516
Muhle automobile storage battery...... 318
National Automatic Telephone Co. exchange switch 143
——enclosed arc lamp 96
New England Electric fuseless rosette.. 605
Novelty Electric fusible plug and receptacle 315
Ohmmeter, Evershed; Queen & Co. 413
Oil engine, Mietz & Weiss, in residential lighting plant 315
——separators, Baum, ... 464
Oiler, Sargent gas engine; Michigan Lubricator Co. 95
Olds gasoline runabout automobile...... 147
Omnigraph for teaching telegraphy..... 248
Outlet box, Floor water-tight; General Incand. Arc Lt. Co......................... 606
Packing, Galvanic rod 373
——, P. P. P. rod; Quaker City Rubber Co. 53, 316
Palmer marine motor 198
Palmer & Olson enclosed motor 200
Panel board with removable enclosed fuse carrier, G. I. 515
Paragon sewing machine motor and regulator 414
Photometer screen, Queen, ... 56
Pliers, Smith & Hemenway insulated, 98; Non-brittle diagonal cutting........ 462
Plug and receptacle, Midget; Marshall-Sanders Co. 555
—— ——; Novelty Elec. Company...... 315
—— ——, Pringle porcelain, ... 52
—— ——; Zimdars & Hunt,............. 53
Potter mesh separator and superheater; Jas. Beggs & Co. 516
Powell lever throttle valve 462
Power Specialty Co. boiler tube cleaner 250
P. P. P. rod packing; Quaker City Rubber Co., 53; for steam plants, ... 316
Pringle porcelain plug and flush receptacle 52
Projector for stage illumination; Baker & Fox 463
Protector, D. & W. telephone............. 144
Pump, Smith-Valle direct-acting pressure, ... 95
——, Stewart double-plunger power, ... 316
Queen photometer screen 56
Receiver. See Telephone receiver.
Receptacle, Brewster improved sign-lamp; Electric Motor & Equipment Co. 249
——, Midget plug and; Marshall-Sanders Co. 555
——, Plug and; Novelty Electric Co.... 315
——, Pringle porcelain plug and flush. 52
——; Zimdars & Hunt.................... 53
Reflector, Parabolic adjustable; Faries Mfg. Co. 605
Reflectors, Kinsman; McLeod, Ward & Co. 557
Refrigerating outfit, Triumph, ... 55
Regulator for series groups of enclosed arc lamps, G. I. 52
——, Paragon sewing machine motor and, ... 414
Reliance dynamos and motors........... 605
Replogle relay-returning water-wheel governor 56
Reynolds flasher for illuminated signs.. 606
Rheocrat current regulator; Erie Exploration Co. 413
Richmondt electrogalvanized conduit.... 54
Roberts fixture block....................... 198
Roche igniter for explosion engines, 374; Incandescent flashlight 557
Rosette, Fuseless; New England Elec. Mfg. Co. 605
Sargent gas engine oiler; Michigan Lub. Co. 95
Schmidt (Lambert) automatic-reset intercommunicating telephone, 54; Double-pole telephone receiver, 143; Private telephone systems 246
Scott high-pressure valve; Roe Stephens Mfg. Co. 55
Separator. See also Oil and Steam separator.
Separator and superheater, Potter mesh; Jas. Beggs & Co. 516
Signalphone, Yurgae fire alarm and police, ... 463
Sims steam exhaust head 463
Smith & Hemenway insulated pliers, 98; Linemen's climbers, 198; Non-brittle diagonal cutting pliers 462
Smith-Valle direct-acting pressure pump 95
Socket, Hubbell chain pull, ... 463
Spencer intercommunicating desk telephone set, 198; telephone outfit 147
Stage illumination, Arc lamp and color screens for; Baker & Fox................ 463
"Standard" howler 200
Stanley spherical-coil indicating wattmeters 317
"Star" screw-cutting engine lathes; Seneca Falls Mfg. Co. 199
Steam engines, Heavy duty Corliss; Vilter Mfg. Co. 198
——separators, Baum, ... 464
Stewart double-plunger power pump.... 316
Stilwell-Bierce turbine and Thresher direct-connected dynamo 250
Stoddard long-distance telephone outfit 145
Storage battery, Muhle automobile...... 318
Sturtevant compact generating set, 245; Eight-pole motors and generators, 462; Hot-blast apparatus 97
Sun Elec. telephone outfit....Adv. 33, Mch.
Superheater, Potter mesh separator and; Jas. Beggs & Co. 516
Surgical operations Lundell motor for; Sprague Elec. Co. 516
Switch, General Incandescent electro-mechanical, 247; G. I. Panel board with removable fuse carrier and switch.... 515
——, Hart "Diamond H" automatic door, 556; Flush switches.............. 320
——, Jones time, ... 97
——, Marshall-Sanders three-ampere snap, ... 464
——, Zimdars & Hunt quick-break, ... 515
Switchboard, Combined exchange and toll-line; Western Telephone Construction Co. 145
——, Haines & Noyes 30-drop desk-type telephone, ... 144
Telegraph sounder, Foote-Pierson main-line 98
Telephone. See also Interior Telephone.
Telephone apparatus, Garton-Daniels extension circuit, ... 146
——bell, Holtzer-Cabot extension, ... 143
——equipments, Ericsson hotel, ... 248
——exchange motor-dynamo, Holtzer-Cabot, ... 55
—— ——switch, "National" automatic, ... 143
——jack and tubular drop, Couch & Seeley combined, ... 144
——lightning arrester and fuse block, Single-pole; American Electric Fuse Co. 146
——line appliances, Barron, ... 315
——magnetos; Connecticut Tel. & Elec. Co. 146
——outfits; Central Tel. & Elec. Co.... 373
—— ——, Farr, ... 147
—— ——, Mianus, ... 147
—— ——, Spencer intercommunicating, ... 147
—— ——, Stoddard long-distance, ... 145
—— ——; Sun Electric Co..Adv. 33, Mch.
——protector, D. & W..................... 144
——receiver, Schmidt double-pole........ 143
——set, Central Tel. & Elec. Co. wall.. 147
—— ——, Spencer intercommunicating desk 198
——, Schmidt automatic-reset intercommunicating 54
——, Standard 200
——switchboard. See Switchboard.
——system, De Veau switchless intercommunicating; Stanley & Patterson.. 148
—— ——, Schmidt private................ 246
——transmitter and receiver, Keelyn.. 148
—— ——, Kellogg 555
Testing instruments. See Instruments.
——outfit, Fisher cable.................... 415
—— ——, Acme portable; Queen & Co. 246
——set, "Aone" portable; E. G. Willyoung 514
Thresher direct-connected generator and Stilwell-Bierce turbine 250
Time switch; J. Jones & Son............. 97
Torches, Clayton & Lambert; Alcohol and gasoline, 247; Gasoline, 413; Gasoline, with handle and pump combined, 96; Handy pocket.......................... 372
Tower. See Cooling Tower.
Transformer construction, Kuhlman improved, ...Adv. 35, Sept.
Transformers, Manhole; Pittsburg Transformer Co. 557
Transmitter. See Telephone transmitter.
Trap, Wright safety water column and emergency, steam 415
Tricycle, Crest motor........................ 98
Triumph motor and air compressor...... 55
Triumph water-cushioned turbines....... 318
Tube cleaner, Power Specialty Co., boiler 250
—— ——, Weinland mechanical; Lagonda Mfg. Co................................ 200
—— ——rod, Butman boiler; Jas. McCrea & Co. 414
Turbines, McCormick; S. Morgan Smith Company; Boston & Montana Mine, 415; Comstock Mine..................... 516
——, Stilwell-Bierce 250
——, Trump water-cushioned............. 318
Valve and low-water alarm, Crane blow-off 96
——, Bordo plug 97
——, Croslen reducing 414
——, Darling gate 249
——, Powell lever throttle................ 462
——, Scott high-pressure; Roe Stephens Mfg. Co. 55
Vilter-Corliss engines, Heavy duty...... 198
Wattmeters, Stanley spherical-coil indicating 317
Webster cord adjuster...................... 375
Wehnelt interrupter for X-ray coils; Willyoung 248
Weinland mechanical tube cleaner; Lagonda Mfg. Co............................ 200
Western Tel. Con. Co. combined exchange and toll-line switchboard...... 145
Wheatstone bridge, Willyoung portable 514
"Wheeler-Admiralty" surface condenser at the Pan-American Exposition...... 374
Wheeler enclosed natural-draft cooling towers 199
Willyoung faradmeter, 514; Portable testing instruments, 96, 514; Wehnelt interrupter, 248; Wheatstone bridge......... 514
Wrench, Elgin adjustable pipe; Western Elec. Co. 56
Wright safety water columns and emergency steam traps......................... 415
Yurgae fire alarm and police signalphone 463
Zimdars & Hunt flush plug receptacle, 53; Quick-break switch................. 515

New Orleans Drainage Commission Lines, Pole setting on the..................... 208
—— ——, Testing consumers' meters at 299
New York Central tunnel, (Edit)...... 401
Niagara Falls, Another power plant for. 292
—— ——convention of the National Electric Light Association, 330; (Edit.) 355
Northwestern Electric Association, 69; Election of Officers 78

O

Obituary:
Dickerson, John W............Adv. 31, July
Eberhardt, Ulrich..............Adv. 37, May
Erickson, Eric E............Adv. 39, April
Gleason, Elliott P.......................... 563
Godfrey, James W.,..........Adv. 35, Dec.
Gramme, Zenobe Theophile............. 119
Gray, Prof. Elisha.......................... 98
Judson, J. Lee.............................. 563
Lawrence, Washington H....Adv. 57, Jan.
Luscomb, Henry Herbert....Adv. 37, May
Mason, George ....Adv. 37, Oct.
Matthiessen, Francis O......Adv. 30, April
Murray, James J..............Adv. 35, Dec.
Rowland, Prof. Henry A.................. 224
Schlesinger, Charles..........Adv. 37, May
Swoope, C. Walton........................ 563
Waring, John.................Adv. 31, July
Ohmmeter for workshop use...............*348
Oil lamp as applied to commercial photometry, By Edwin J. McAllister...... 397
Omega storage battery plate...............*26

Orsatt gas analyzer, By A. Bement, 484; (Edit.) 498
Outhenin-Chalandre electrolytic alkali process *289

P

Packing, Metallic gland.... *491
Pan-American Exposition. Awards, 561; Bernard Company's plant, Adv. 35, Sept.; Decorative lighting, 340; (Edit) 354; Electrical illumination and fountains, 154; Exhibits, 368, 416; Service plants 425
Parallel operation, Relation of characteristic curves of direct-current dynamos to, By Alton D. Adams.... 68
Pelton electric relay water-wheel governor 604
Permeameter for iron and steel.... *443
Petroleum in boilers, Use of.... *578
Phase (Edit.) 541
Phoenix lightning arrester and self-restoring telephone switchboard drop. 139
Photometer, A simple.... 296
——for central stations, The choice of a, By Wilbur M. Stine.... 266
——scale, Formula for, (Q. & A.).... 138
——sight boxes, By Wm. B. Hodge.... 352
Photometric measurements, By F. Everett Lindsey 408
Photometry, The oil lamp as applied to commercial, By Edwin J. McAllister. 397
Pipe fitting flanges, Standardization of.. 539
Pipes, An experience with scale in blow-off, By Chas. W. Oliver.... 403
——, Steam, Transverse stresses in, By A. S. Mann....528, 574
Plante storage battery plate.... *25
Plants. See Industrial and Power plants.
Plating machine for arc-lighting carbons, Automatic; United States Carbon Co. 51
Electroplating solution for silver (Q. & A.) 552
Platinum electrode, New form of.... *537
Plug, A new telephone circuit.... *115
——, Grabosch combined ammeter and socket, (patent) 222
——, Swoboda wall receptacle and, (patent) 538
Polarity, Freaks due to reversal of line, By E. C. Parham 502
——of electrodes and terminals (Edit.).. 499
Pole finders *114
——piece dimensions, By George W. Malcolm 240
—— ——, Merrick dynamo or motor, (patent) 396
——preservation, Salt for.... 402
——setting on the New Orleans Drainage Commission Lines 208
Polyphase. See also Three-phase.
——currents, Direct current vs.... *26
Portland General Electric Company, Some of the special features of the system of the.... 105
Power in alternating-current circuits; Method of measuring.... *115
——plant, Dixon Crucible Company's... 517
—— ——, Hints on laying out a.... 495
—— ——, Niagara Falls 292
—— ——, Snoqualmie Falls, Extension of 497
—— ——, Swift & Co.'s.... 149
—— ——, Walla Walla turbine-driven, 603
—— ——, Wetmore Tobacco Factory, By F. E. Bausch.... 61
——plants, Pan-American Exposition.... 425
Principles of electricity, Fundamental, (Lessons) 454
Problem, An arc-light, By F. J. Collins, 408; Joel Gomborow, 310; Albert J. Levine, 310; F. M. Swalm.... 240
——, A wiring, By Arthur Barthels, 89; Fred Dustin, 46; Ralph G. Focht, 46; Geo. W. Malcolm, 46; W. C. Townsend, 46; A. R. Van Volkenburgh.... 46
——, Bell wiring, By Leslie E. Carpenter, 549; John H. Hamilton, 550; H. W. Korhammer, 549; George W. Malcolm, 550; John R. Pusnell, 549; Arthur A. Schuhmann, 508; Arthur B. Smith, 549; G. Weber.... 549
——in connections, By F. E .Austin, 310; Arthur Barthels, 363; B. G. Eckard, 309; H. L. Francis, 363; L. D. S. Gaster, 310; W. P. Jackson, 363; J. S. Jenks, 409; Albert J. Levine, 309; George W. Malcolm, 309; George Moutonnet, 239; Edwin Place, 363; Chas. J. Sutter.... 309
——, Field connection, By F. P. Woodbury 599
——in lamp control, A, By Chas. J. Sutter 599
——in mechanics, By J. C. Brocksmith, 455; H. Scott Dodson, 455; Joel Gomborow, 455; Charles M. Green, 455; Charles H. Holderrieth, 408; Edgar D. Tillyer, 456; J. M. Walker.... 455
Prony brake *289
Protective device on the three-wire system, By C. R. James.... 88
Pump, Electric express.... *535
——, Mather & Platt motor-driven feed. *219
Pumping feed water, Heating and, (Edit.) 81
Pumps, Boiler feeding, By C. W. Obert.. 304
Pupin's discovery, Prof., By Daniel Higham 496
——system of inductance coils (Edit.).. 80
Puzzle. See Problem.

R

Radiators, Dowsing luminous electric.... *24
Rail bond, Pringe, (patent) 351
Railway block-signal system, Single-track, By P. E. Moock.... 598
—— car control, Electric, (Edit.).... 31
—— ——lighting system, Gould.... 313
—— ——notes, By Arthur B. Weeks.... 233
—— ——troubles, By A. B. Weeks.... 47
——condition, An unusual, By E. C. Parham 129
——conduit. See Conduit.
——controllers, The care of street, By Frank Berry, Jr.... 596
——generators, Bucking of, By E. C. Parham, 86, 408; Geo. W. Malcolm, 135; Ed. S. Morgan.... 240
——line polarity, Freaks due to reversal of, By E. C. Parham.... 502
——motor armatures, Stripped, By Frank Berry, Jr. 454
—— ——control, Parham method of, (patent) 351
—— ——, Priest, (patent) 78
—— ——starting resistance, By Edward Chilton 136
——motors, Weak fields and grounded armatures in, By Frank Berry, Jr. 189
——plant with alternating-current transmission, Water-power; Kalamazoo Valley Electric Company.... 321
——practice, A peculiar but instructive incident in, By E. C. Parham.... 544
——signal system, A simple, By E. C. Parham 34
——system, Sprague multiple-unit, By Edward Chilton, 39; Main motor circuits, 234; Pilot motor circuits, 302; safety provisions 404
——systems, Helios and Schuckert surface contact *25
——, Three-phase motors for the London Metropolitan Underground.... *173
——, Van Dorn third-rail electric, (patent) 291
Rapid Transit subway power station.... 539
Rating of enclosed motors and dynamos, (Edit.) 585
Reactance and inductance, (Edit.).... 31
Receiver. See Telephone receiver.
Receptacle and fuse plug, Swoboda wall, (patent) 538
Rectifier, A Chemical, By C. Hazen Farnham 310
Reflection of light, The.... 179
Reflectors for searchlights, Parabolic.... 424
Regenerator and accumulator, Steam.... *577
Regulating devices for series alternating-current circuits, By J. Henry Hallberg, 529; (Edit.).... 540
Regulation for series alternating-current arc lamps, A system of; Western Electric Co.... 94
——of rotary converters.... *26
——of shunt-wound motors, Speed.... *442
Regulator for series alternating-current circuits, (patents) Baker, 579; Sprong. 396
Resistance, A useful form of "dead," (Edit.) 181
——of simple and complex circuits (Lessons) 507
——, "Ohmic," (Edit.).... 448
——, Railway motor starting, By Edward Chilton 136
——wire, Formula for the size of iron, (Q. & A.) 552
—— ——submerged in water, Formula for the size of, (Q. & A.).... 552
Rheostat, A water cooled, By Geo. N. Tidd 90
——construction, Water, By Francis H. Doane 193
——, Hewlett motor-starting, (patent)... 117
Rheostats, Immersed vs. water, By B. Parks Rucker 72
Robbins & Myers. A rising establishment Adv. 35, Dec.
Rosette, Trumbull ceiling, (patent).... 78
Rotary converter. See Converter.
Rotor, Action of an induction motor, (Lessons) 190
Rowland, Prof. Henry A.... 224
Russian steam engine for electric lighting service; Bromley Bros.... 111

S

Salt for pole preservation 402
Santa Monica plant of the United Electric, Gas & Power Company, By J. R. Cravath, 251; (Edit.).... 294
Scale in blow-off pipes, An experience with, By Chas. W. Oliver.... 403
—— ——boilers, Effect of.... 495
—— —— ——, Formation of *220
—— —— ——, Prevention of hard.... *578
Scales, Clarke automatic coal-weighing.. 511
Schmidt system of superheating.... *443
Schuckert and Helios surface contact railway system *25
——revolving light synchronizer.... *537
Searchlights, Parabolic reflectors for.... 424
Self-induction in the rotor of an induction motor, Effect of, (Lessons).... 238
Series-parallel system of control for printing-press motors, C & C.... 50
Shop notes, Repair, By Arthur B. Weeks.. 125
Short-circuit between electrical conductors, A simple method of locating a, By Arthur R. Roe.... 208
Short cuts to knowledge, (Edit.).... 295
Shunt for dynamo compounding coils, Hobart, (patent) 397
Shunts and transformers for electrical measuring instruments, Switchboard; Machado & Roller.... 244
——, Galvanometer *536
Siemens & Halske induction meter.... *534
Signal apparatus, Simple time, By S. M. Kintner 402
——system, A simple railway, By E. C. Parham 34
—— ——, Single-track railway, By P. E. Moock 598
—— ——for telephone party lines, Metropolitan 511
—— ——under difficulties, Working a, By E. R. Avery.... 599
Silver plating, Solution for, (Q. & A.).... 552
Simon interrupter, Improved.... *350
S. K. C. frequency changer; Stanley Elec. Mfg. Co. 243
Skinner high-speed engine, Test of a.... 197
Sleet cutter, A handy, By A. A. Deighton. 310
——cutters, By Arthur B. Weeks.... 85
Snoqualmie Falls power plant, Extension of the 497
Socket shell, Perkins incandescent lamp, (patent) 351
Soda and chlorine, Electrolytic production of, By Ernest Franke.... 104
Solenoid, Magnetomotive force and field of a, (Lessons).... 597
Solenoids, Windings for electromagnets and, ...155, 209
"Solid" telephone receiver; Wm. J. Murdock & Co.... 139
South Carolina Inter-State and West Indian Exposition 293
Sparking at commutator brushes, (Edit.). 401
Sparkless disconnection of shunt motors. *348
Speed indicator, Storer magnetic, (patent) 538
——regulating device, Kragh motor-starting and, (patent).... 580
——variation, Measuring *442
Sperry automobile storage battery; National Battery Co.... 554
Standardization of pipe fitting flanges.. 539
Standards, German Imperial electrical.. *395
Stator of an induction motor, (Lessons).. 307
Steam boilers and pipes, mica lagging for. *176
——delivery, Gehre meter for measuring. *116
——, Efflux of *536
——engine, A French Corliss-type.... 214
—— ——, Another motive wonder, By A. A. Deighton 456
—— ——for electric lighting service, Russian 111
—— ——construction, Modern practice in 256
—— ——cylinder proportions *491
—— ——efficiency, By A. F. Nagle, 113, 178; (Edit.) 120 181
—— ——governor. See Governor.
—— ——, Lane & Bodley Twentieth Century 367
—— ——Selection of a, By W. D. Ennis 338
—— ——, Test of a high-speed Skinner. 197
——engineering, A century of progress in, By A. F. Nagle.... 17
——engines, Clearance and compression in *219
—— ——for Brooklyn Edison plant, New Westinghouse 108
—— —— ——Glasgow Tramways, Allis 390
—— ——, Recent types of American and European 106
—— ——, Starting up, By W. C. Townsend 134
——gauges, Construction, calibration and care of, By C. W. Obert.... 337
——heating plant, A combined lighting and, By W. N. Zurfluh.... 201
—— ——vs. condensing, Exhaust, By A. M. Earl 89
——injectors. See Injectors.
——pipes. See Pipes.
——production, Economy in, By C. W. Obert 217
——pumps. See Pumps.
—— regenerator and accumulator.... *577
——Superheated. See Superheated steam.
——tables, By Chas. L. Hubbard, 432; (Edit.) 449
——turbine. See Turbine.
Sterling incandescent lamps, Symmetrical distribution from 513
Stocker fanless water-cooling towers.... 412
Storage battery, Automobile *492
—— ——cases, Closing portable.... *394
—— —— cell, Max.... *578
—— ——connections, Kent, (patent).... 177
—— ——, Curves for showing the charge remaining in a.... 436
—— ——element, (patent) 77
—— ——end-cell switch *290
—— ——lugs, Bolt for connecting.... *173
—— ——meter, Haskins, (patent).... 77
—— ——pasted plates, Formula for,.... 365
—— ——, Phosphoric *443
—— ——plate, Omega.... *25
—— —— ——surface, per ampere of current, (Q. & A.) 242; By Wm. W. Donaldson 363
—— ——, Sperry automobile; National Battery Co. 554
—— ——terminals, Joining, (Q. & A.).. 510
Storage batteries, Boosters and, (Diagrams) 195
—— ——controlled by reversible boosters *442
—— ——, Increasing the capacity of lead *395
Street lighting, Reflector incandescent lamps for *24
—— ——, Relative merits of open and enclosed arc lights for, By W. D'A. Ryan, 522; (Edit.).... 541
—— —— system, Peculiar.... *578
Stroud telephone toll-service recorder; National Measured Service Co.... 141

Superheated steam, Boilers and engines for, 395; (Edit.).............................. 400
—— ——in engines, Some experiences and results derived from the use of, By R. Lenke 525
Superheating apparatus, Commercial types of steam, By Geo. A. Hutchinson 426
——, Schmidt system of.................... *443
Swift & Co. centralized power plants at Chicago and St. Joseph................ 149
Switch and fuse holder, Linton combined, (patent) 444
——, Automatic transformer..........*114, *442
——, Bossert knife-blade, (patent)........ 222
——, Johnson single-break knife, (patent) 494
——, Storage battery end-cell..............*290
Switchboard. See also Telephone switchboard.
——shunts and transformers for electrical measuring instruments; Machado & Roller 244
Switches for controlling lights from more than one point, By Francis M. Appleton 47
Synchronizer, A new, By Fred P. Woodbury 527
——, Schuckert revolving light...........*537
Synchronizing alternating-current machines, (Edit.) 227
——system for alternators, York, (patent) 222
Synchronous motor, The, (Lessons) 362; Phase relations in, (Lessons).......... 407

T

TABLES:
Electrical horse-power........Adv. 37, Oct.
Electromagnets, Windings for, 156, 210, 211, 212
Incandescent feeders and main.......... 595
Photometer scale, Construction of a. 297
Pipe fitting flanges, Standardization of extra heavy 539
Pole-piece dimensions 240
Turbines, Trials of steam............. 539
Wires at negligible drop, Capacities of. 509
——, Currents required for melting
——Current limit for.................... 594
copper, lead and solder.............. 48
——in ordinary and immersed rheostats, Safe capacities for iron.... 74
——, Safe currents for aluminum and copper 29
Telegraph keyboard, Modification of the Hughes *173
Telegraphy. See Wireless telegraphy.
Telephone booths, Lister automatic lighting system for, (patent)................. 580
—— cable carriers, By W. S. Henry.... 403
——call recorder, McBerty, (patent).... 581
——circuit plug, A new..................*115
——cord circuit, Scribner, (patent)........ 291
——exchange at Atlanta, Ga., Independent, By E. E. Clement.............. 19
—— ——at East Cleveland, (Ohio), A notable independent, By George L. Burlingame 99
—— ——notes, By W. S. Henry.......... 591
—— ——without cords, Small...........*395
——generators, Efficiency of, By W. S. Henry 453
——party lines, Metropolitan selective signaling system for 511
——receiver, "Solid"; Wm. J. Murdock & Co. 139
——set, Construction of an intercommunicating 122
——switchboard, Eureka, ... 140
—— ——drop, Phoenix lightning arrester and self-restoring................ 139
—— ——, Modern, By Kempster B. Miller 282
—— —— Prevention of cross talk in; McBerty, (patent) 290
—— ——Small, By W. S. Henry......36, 84
—— ——systems, Common battery, By W. S. Henry..........128, 189, 229, 300, 361
——system, Clarke automatic 141
——systems, Diagrams of, By H. S. Webb 409
——toll-service recorder, Stroud; National Measured Service Co.......... 141
——transmitter, (patents) Perkins, 28; Skold, ... 117
—— ——diaphragm, Method of measuring the vibration of a, By W. L. Merrill 67
Telephony, Long distance and ocean, (Edit.) 80
Temperature, Absolute, (Edit.).............. 226
Terminals, Polarity of electrodes and, (Edit.) 499
Terminology, Alternating-current, (Edit.) 584
Tesla's latest (Edit.) 81
Test. A simple method of locating a short circuit between electrical conductors, By Arthur R. Roe.......... 298
——. Insulation, ...*175
——of a high-speed Skinner engine........ 197
——of a large gas engine using producer gas *116
Tester. A convenient circuit, By J. A. Keniston 135
Testing alternating-current meters on artificial loads *114
——cells and batteries in the Royal Navy *175
——consumers' meters at New Orleans. 299
——device, Kitsee insulation, (patent).. 538
——of fan motors, Comparative, By A. R. Everest, 366; S. D. Gilbert........ 307
——Points on insulation, By Fred P. Woodbury 34
——purposes, Adjusting voltage for......*394
——with a voltmeter, Armature, (Q. & A.) 93
——without a dynamometer, Electric motor, ... 501
Tests of Wagner single-phase motors.... 94
——, Gas engine efficiency, ... 329
Three-phase currents, Esson cable for, (patent) 538
—— induction motors, Starting...........*579
——motor, Formula for horse-power of a, (Q. & A.) 552
——motors for the London Metropolitan Underground Railway, Ganz *173
——secondary voltages, Simple method of obtaining two, 339; O. A. Honnold 409
——systems, Aron meter for four-wire,..*288
Three-wire distribution from rotary converters, By Chas. N. Black........... 550
—— —— ——transformers; Pittsburgh Transformer Co. 461
—— ——system, Circuit protection on the, By C. R. James................. 58
—— —— ——, Heath, (patent) 494
—— ——trouble, A, By R. C. Chipman, 136; Chas. W. Davis................. 192
Thresher direct-current motors in Brooklyn Navy Yard shops................ 602
Time signal apparatus, Simple, By S. M. Kintner 402
Toll-service recorder, Stroud; National Measured Service Co. 141
Tool handles, A formula for, By R. M. Gaston, 409; Harry Gwinner......... 455
Torque, Formula for direct-current armature, (Q. & A.).......................... 510
Transformer connections (Lessons) *288
—— ——, Fort Wayne shell-type, ... 142
——, Rice polyphase, (patent) 290
——station of the Cataract Power and Conduit Co., The new Buffalo terminal, By Fred P. Woodbury........... 385
——switch, Automatic, ...*114 *442
—— ——connections, Boosting, By E. W. Lothrop 239
——trouble remedied, By Elmer K. Swift 90
Transformers, By A. S. McAllister........ 471
——for electrical measuring instruments, Switchboard shunts and; Machado & Roller 244
——for the Manhattan Elevated, Westinghouse, ... 197
——, Measuring voltage drop in.........*577
——, Three-wire secondary distribution from; Pittsburgh Transformer Co.. 461
Transmission line wires, Distance apart of, (Q. & A.) 510
——plant and sub-stations of the Kalazoo Valley Elec. Co..................... 321
—— ——at Santa Monica, Cal., By J. R. Cravath, 251; (Edit.).................. 294
Transmitter. See Telephone transmitter.
Traps for disposing of the water of condensation, By C. W. Obert........... 235
Trolley, A plain but efficient. By Ed. B. Cheatham, 89; C. D. Woodward...... 193
Turbine, De Laval steam, ... 553
——for dynamo propulsion, The steam, By C. W. Obert...................... 504
Turbines, Trials of steam, ... 539
Turbines, McCormick, in Walla Walla power plant, ... 603
Twentieth Century engine; Lane & Bodley Co. 367

U

Underwriters' National Association........ 29
United States Carbon automatic plating machine for arc-light carbons........ 51

V

Valve, A new steam stop...................*173
——gear and valve setting, Corliss, By C. C. Major 230
Valves and trapped water, Globe, By R. A. Douglass 130
Varnish, A recipe for bronze,.............. 224
——, Insulating, ...*220
Voltages, Direct-current, (Edit.)........... 355
Voltmeter, Alternating-current ammeter and, ... *74
——, The construction of a direct-current 500
——, Simple method of calibrating a, By J. Rowland Brown.................... 573
Voltmeters, High-tension, ...*290

W

Wagner motors, Tests of single-phase,.... 94
Walla Walla turbine-driven power plant.. 603
Waste of a gas engine, Heat, (Edit.) 180; Philip K. Stearn.................... 292
Wastes, Neglected heat, By R. A. Douglass 520
Water column connections, By C. W. Obert, ... 452
——gauge, Huyette quick-closing,........ 243
——hammer 172
——rheostats. See Rheostats.
—— wheel efficiency and operation, (Edit.) 585
Watt-hour meter, Alternating-current,...*115
Wattmeter, Hartmann & Braun astatic.. *27
——, Hot-wire, ...*579
——, Reading a recording,.............. 360
Western Electric system of regulation for series alternating-current arc lamps 94
Westinghouse steam engines for Brooklyn Edison plant, New.................... 108
——transformers for the Manhattan Elevated Railroad 197
Wetmore Tobacco Factory, St. Louis, Mo., Induction motors in the power plant of the, By F. E. Bausch.............. 61
Whitehead steam-engine governor.... *578
Winding for electric motors, Warner starting, (patent).................... 351
Windings for electromagnets and solenoids 209
——, Magnet, (Edit.)...................... 121
Wire, Formula for the size of iron resistance, (Q. & A.)...................... 552
——submerged in water, Formula for the size of resistance, (Q. & A.).......... 552
Wireless telegraph receiver, Marconi, (patent) 177
——telegraphy *77
Wiring. See also Interior Wiring.
Wiring, Alternating-current conduit, By C. R. James.......................... 599
——problem. See Problem.

Z

Zinc in boilers, On the use of, By R. A. Douglass 572

AUTHOR INDEX.

Adams, Alton D. Direct-current dynamos in parallel.............................. 237
——Relation of characteristic curves of direct-current dynamos to parallel operation 68
——Starting and stopping direct-current dynamos operated in parallel......... 37
——The Atlantic Avenue Station of the Boston Edison Company.............. 268
Appleton, Francis M. The control of lights from more than one point.... 47
Austin, F. E. A problem in connections 310
Avery, E. R. Working a signaling system under difficulties.................. 599

Barthels, Arthur. Another answer to the wiring puzzle 89
——A problem in connections............. 363
Bausch, F. E. The power plant of the Wetmore Tobacco Factory........... 61
Bement, A. Loss in economy by the incomplete combustion of fuel.......... 484
Berry, Frank, Jr. The care of street-railway controllers 596
——Stripped railway motor armatures.. 454
——Weak fields and grounded armatures 189
Birks, Lawrence. Electrical progress in Australasia 267
Black, Chas. N. Three-wire distribution from rotary converters................. 550
Brocksmith, J. C. Design for a 1-h.p. gas engine 580
——A problem in mechanics.............. 455
Broili, F. O. Another mysterious current 308
Brown, J. Rowland. A simple method of calibrating a voltmeter................ 573
Burlingame, George L. The lamp signal branch exchange at East Cleveland, Ohio 99

Carpenter, Leslie E. A problem in bell wiring 549
Carr, H. Stanley. That mysterious current 193
Cheatham, Ed. B. A plain but efficient trolley 89
Chilton, Edward. Railway motor starting resistance 136
——Sprague multiple-unit railway system, 89; Main motor circuits, 234; Pilot motor circuits, 302; Safety provisions 404
Chipman, R. C. A three-wire trouble.... 136
Clark, E. B. Lifting electromagnets...... 64
Clement, E. E. The Independent Telephone Exchange at Atlanta, Ga...... 19
Collins, F. J. An arc-light problem...... 408
Cravath, J. R. A steam-driven electrical transmission plant (Santa Monica).. 251

Davis, Chas. W. Mr. Chipman's three-wire trouble 192
Deighton, A. A. A handy sleet cutter.... 310
——Another motive wonder............... 456
Doane, Francis H. Points in water rheostat construction 193
Dodson, H. Scott. A problem in mechanics 455
Donaldson, Wm. W., storage battery plate surface 363
Douglas, R. A. A few common boiler troubles 265
——Globe valves and trapped water...... 130
——Neglected heat wastes................. 520
——On the use of zinc in boilers.......... 572
——Pulverized fuel 434
Dustin, Fred. A wiring puzzle.............. 46

Earl, A. M. Engine cylinder cutting...... 408
——Exhaust steam heating vs. condensing 89
Eckard, B. G. A problem in connections 309
Ennis, William D. A hint for practical engineers 264
——Boiler room efficiencies........ 388
——Brick chimneys for power stations.. 570
——The central station boiler room...... 327
——The relation of the rate of evaporation to the fuel economy of boilers.. 521
——The selection of a steam engine...... 338
Everest, A. R. The comparative testing of fan motors 366

Farnham, C. Hazen. A chemical rectifier 310
Focht, Ralph G. A wiring puzzle.......... 46
Francis, H. L. A problem in connections 363
Franke, Ernest. Electrolytic production of soda and chlorine........ 104

Gallo, P. M. Adjusting an electrodynamometer 240
Gaster, L. D. S. A problem in connections 310
Gaston, R. M. Wanted: A formula for tool handles 409
Gilbert, S. D. Comparative testing of fan motors 307
Gomborrow, Joel. An arc-lighting prob[illegible] 310
[illegible]oblem in mechanics........ 455
[illegible]dard candle-power of incandescent lamps 408
Graham, B. Effect of reversing a field coil on a multipolar generator........ 90
Green, Charles M. A problem in mechanics 455
Gwinner, Harry. A formula for tool handles 455

Hallberg, J. Henry. Regulating devices for series alternating-current circuits 529
Hamilton, John H. A problem in bell wiring 550
Hanchett, George T. That mysterious current 192
Hart, B. Franklin, Jr. The use of cooling towers 474
Haskins, Caryl D. Improved permanent-magnet measuring instruments...... 508
Heldt, P. M. A comparison of dynamos with surface-wound and slot-wound armatures 106
Henry, W. Common battery telephone switchboard system, 128, 189, 228, 300, 361
——Efficiency of telephone generators.... 453
——Small telephone switchboard systems 36, 84
——Telephone cable carriers........ 403
——Telephone exchange notes........ 591
Higham, Daniel. Prof. Pupin's discovery 496
Hillman, H. W. Arc lighting at the beginning of the twentieth century.... 326
Hobart, James F. Steam flue cleaners 86
Hodge, Wm. Photometer sight boxes.... 352
Holderrieth, Charles H. A problem in mechanics 408
Hollis, Walter M. Improved boosters.... 524
Honnold, O. A. Simple method of obtaining two three-phase secondary voltages 409
Hubbard, Chas. L. Calorimetry,........503, 591
——Steam tables 432
Hutchinson, F. L. Coal-handling machinery in central stations........ 486
Hutchinson, Geo. A. Commercial types of steam superheating apparatus........ 426

Irwin, Wm. G. Electricity in coal mining in the Pittsburg District........ 255

Jackson, W. P. A problem in connections 363
James, C. R. Alternating-current conduit wiring 599
——Circuit protection on the three-wire system 88
Jenks, J. S. Solutions of Mr. Montonnet's problem 409

Keniston, J. A. A convenient circuit tester 135
Kennelly, A. E. Electricity in the nineteenth and twentieth centuries........ 14
Kintner, S. M. The construction of an electrodynamometer 228
——Simple time signal apparatus........ 402
Knox, Charles E. Interior Wiring. Lighting of a department store, 126; Wiring of a large hotel........ 184
Korhammer, H. W. A problem in bell wiring 549

Lenke, R. Some experiences and results derived from the use of highly superheated steam in engines........ 525
Levine, Albert J. An arc-lighting problem 310
——A problem in connections........ 309
Lindsey, F. Everett. Photometric measurements 408
Lothrop, E. W. Boosting transformer switch connections........ 239

McAllister, A. S. Parallel operation of alternators 435
——Rotary converters 568
——Transformers 471
McAllister, Edwin J. The oil lamp as applied to commercial photometry...... 397
Major, C. C. Corliss valve gear and valve setting 230
Malcolm, Geo. W. A problem in bell wiring 550
——A problem in connections........ 309
——A wiring puzzle........ 46
——Compound dynamos in parallel...... 135
——Laying out interior wiring........ 508
——Pole-piece dimensions 240
Mann, A. S. Transverse stresses in steam pipes 528, 574
Mather, L. B. Boiler feeding and feed-water heating 67
Matthews, C. P. Photometric values of arc lamps........ 324
Merrill, W. L. Method of measuring the vibration of a transmitter diaphragm 67
Miller, Kempster B. The modern telephone switchboard 282
Moock, P. E. A single-track block-signal system 598
Morgan, Ed. S. An improvised booster.... 47
——Bucking of railway generators...... 240
——Electric bells on 110-volt circuits...... 89
Moutonnet, George. A problem in connections 239

Nagle, A. F. A century of progress in steam engineering 17
——Steam engine efficiency, 113........ 178

Obert, C. W. Boiler feeding steam pumps 304
——Commercial forms of cooling tower 475
——Construction, Calibration and care of steam gauges........ 337
——Disposing of the water of condensation 235
——Economy in steam production........ 217
——Fly-wheel accidents 131
——The municipal lighting plant at Wappinger's Falls, N. Y........ 565
——The steam turbine for dynamo propulsion 504
——Water column connections........ 452
——Water of condensation........ 187
O'Hanlon, F. B. Some Brush arc-light dynamo troubles and their remedies 596
Oliver, Chas. W. An experience with scale in blow-off pipes........ 403

Parham, E. C. An unusual condition.... 129
——A peculiar but instructive incident 544
——A simple railway signal system...... 34
——Bucking of railway generators....86, 408
——Freaks due to reversal of line polarity 502
Patterson, Ralph J. Central station charging 135
——Operation of engine-driven alternators in parallel........ 239
Place, Edwin. A problem in connections 363
Poole, Cecil P. Design for a 75-light dynamo 82
——Design for a 400-ampere electroplating dynamo 356
——Design for a 35-light incandescent dynamo 450
——Design for a 3-h.p. launch motor.... 542
Pusnell, John R. A problem in bell wiring 549

Roe, Arthur R. A simple method of locating a short circuit between electrical conductors 208
Rosenfield, G. E. The standard candle-power of incandescent lamps........ 455
Rucker, B. Parks. Immersed rheostats vs. water rheostats 72
Ryan, W. D'A. Relative merits of open and enclosed arc lights for street illumination 522

Schmidt, H. F. Modern forms of shaft governor 545
Schmidt, John M. Paralleling of a direct-connected and a belted generator.... 192
Schuhmann, A. A problem in bell wiring. 508
Smith, Arthur B. A problem in bell wiring 549
Stern, Philip K. The heat waste of a gas engine 292
Stine, Wilbur M. The choice of a photometer for central stations........ 266
Sutter, Chas. J. A problem in connections 309
——A problem in lamp control........ 599
Sutton, E. C. Unusual action of an arc-light dynamo 46
Swalm, F. M. An arc-lighting problem.... 240
Swift, Elmer K. Irregular indicator diagrams and a transformer trouble remedied 90

Thompson, O. C. An odd mishap........ 598
Tidd, Geo. N. A water-cooled rheostat.... 90
Tillyer, Edgar D. A problem in mechanics 456
Townsend, W. C. A wiring puzzle........ 46
——Starting up steam engines........ 134
Treload, Wm. D. An unaccountable accident 409

Van Volkenburgh, A. R. A wiring puzzle 46
——Electric bells on lighting circuits...... 46

Walker, J. M. A problem in mechanics.. 455
Walsh, George E. Electrically controlled bulkhead doors 213
Watson, C. A practical demonstration in boiler economy 506
Webb, H. S. Diagrams of telephone systems 409
Webber, S. T. Central station methods.. 550
Weber, G. A problem in bell wiring........ 549
Webster, C. C. An improved booster.... 136
Weeks, A. B. An old-timer........ 573
——Electric car troubles........ 47
——Railway car notes........ 233
——Repair shop notes........ 125
——Repairing and connecting up a generator commutator........ 187
——Sleet cutters 85
——Starting rotary converters........ 358
Williams, E. D. The new chief engineer 478
Williams, J. R. The new power-house equipment of the Consolidated Electric Light & Power Company, Birmingham, Ala........ 421
Wood, H. P. An improved booster........ 136
Woodbury, Fred P. A note on the use of the electrodynamometer 107
——Points on insulation testing........ 34
——The new Buffalo terminal transformer station of the Cataract Power and Conduit Company 385
——A wiring problem........ 599
Woodward, C. D. Another plain but efficient trolley 193
Wurts, Alexander J. Development of the Nernst lamp in America........ 437

Zimmerman, W. H. Plant of the Urbana (Ill.) Light, Heat & Power Company 482
Zurfluh, W. N. A combined electric lighting and steam heating plant........ 201

American Electrician.

Vol. XIII. New York, January, 1901. No. 1.

A REPRESENTATIVE AMERICAN CENTRAL STATION.

THE PLANT OF THE EDISON ELECTRIC ILLUMINATING COMPANY OF BROOKLYN.

For several years past the system of the Brooklyn Edison Electric Illuminating Company has been in slow but sure process of transformation from an aggregation of more or less old-fashioned plants representing various epochs of central station practice into a concrete system embodying the latest types of apparatus and most modern methods of operation. The evolution has been slow because of the stupendous difficulties attending the remodeling of a system saddled with a rapidly increasing 24-hour load; it has been sure because of the unusual foresight and indomitable energy of the company's general manager, Mr. W. S. Barstow, under whose direction all of the work of weeding out obsolete machinery and modernizing the whole system has proceeded. The rehabilitation of the system has now reached a point where it is chiefly a question of getting the remainder of the machinery and apparatus which were ordered months ago, and installing them in the few stations that are yet incomplete.

The system comprises two main generating stations at which three-phase alternating currents are generated at 6600 volts e.m.f., and 25 cycles, and eleven substations to which this current is supplied and which change it into the proper class and voltage for the various classes of distribution. The distributive service consists of two-phase alternating current at 2400 volts and 62 cycles, which is transformed in the usual manner for supplying arc and incandescent lamps and motors in the outskirts of the city; constant direct current, for certain street lighting circuits on which it is deemed advisable to retain this class of service; and constant-potential direct current which supplies an Edison three-wire network in the congested part of the city.

One of the main generating stations is located on the river edge at the foot of Gold street and the other, known as the Union Station, is also on the water-side, but over in the southern part of the city at Bay Ridge. The Gold street station is equipped with six Stirling water-tube boilers of 500-h.p. capacity each. These are provided with under-feed stokers, built by the American Stoker Company, of New York; these machines consist broadly of a feeding retort in which a screw or worm is rotated, feeding the coal into the furnace as it is required. The view of the boiler room, which appears on another page, shows the arrangement for delivering coal to the mechanical stokers. A V-shaped coal bin extends lengthwise over the center of the boiler room and the coal feeds by gravity into the weighing hopper, shown at the top of each boiler front. This hopper contains a scale pan which is connected by a lever to a Fairbanks beam scale, and each hopper of coal is thus weighed before it can reach the chutes leading down to the stokers. Coal is delivered to the station in barges, from which it is carried up to a coal tower at

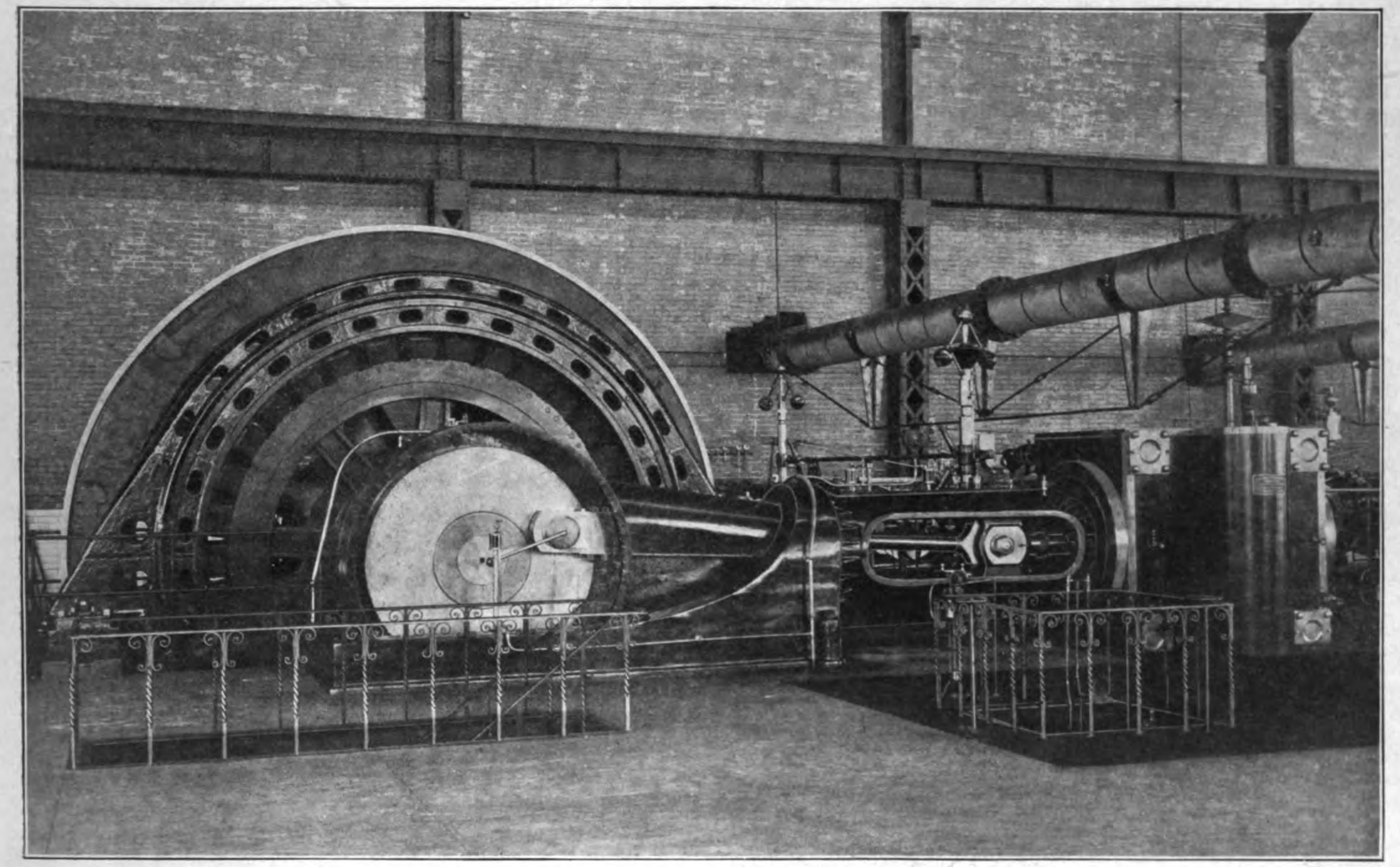


FIG. 1.—ONE OF THE 1000-HORSE-POWER GENERATING UNITS OF THE GOLD STREET STATION.

one end of the coal bin; from the tower a semi-automatic industrial railway car takes coal into the bin, distributing it according to the adjustment of the "trips." The coal-handling apparatus was installed by the C. W. Hunt Company, of New York.

The piping between the boilers and engines is in duplicate throughout. There are two headers in the boiler room and each boiler is connected to these by means of duplicate delivery pipes. From each header an omnibus or trunk supply pipe extends into the engine room, as shown in the general view of that room, Fig. 1. These pipes turn down and terminate in separators beneath the engine-room floor, and the separators deliver in turn to two steam headers from which duplicate individual supply pipes lead to the engines. The feed-water is heated entirely by the exhaust steam from the blower engines and various pumps, no heater being inserted in the exhaust piping of the main and exciter engines. Jet condensers built by the E. P. Allis Company, Milwaukee, are used in connection with all of the engines that drive generators.

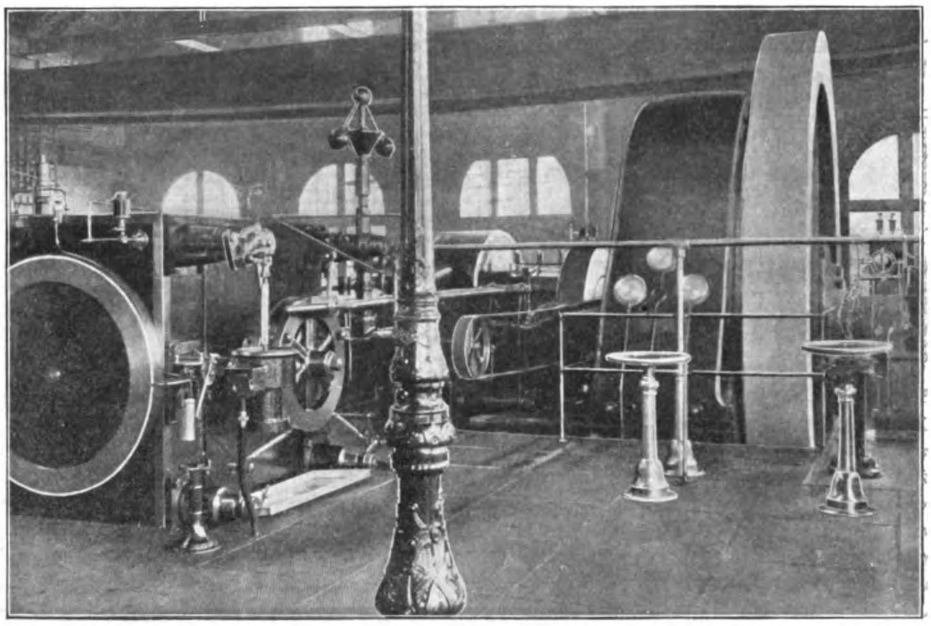


FIG. 3.—A PARTIAL VIEW OF THE VALVE-GEAR.

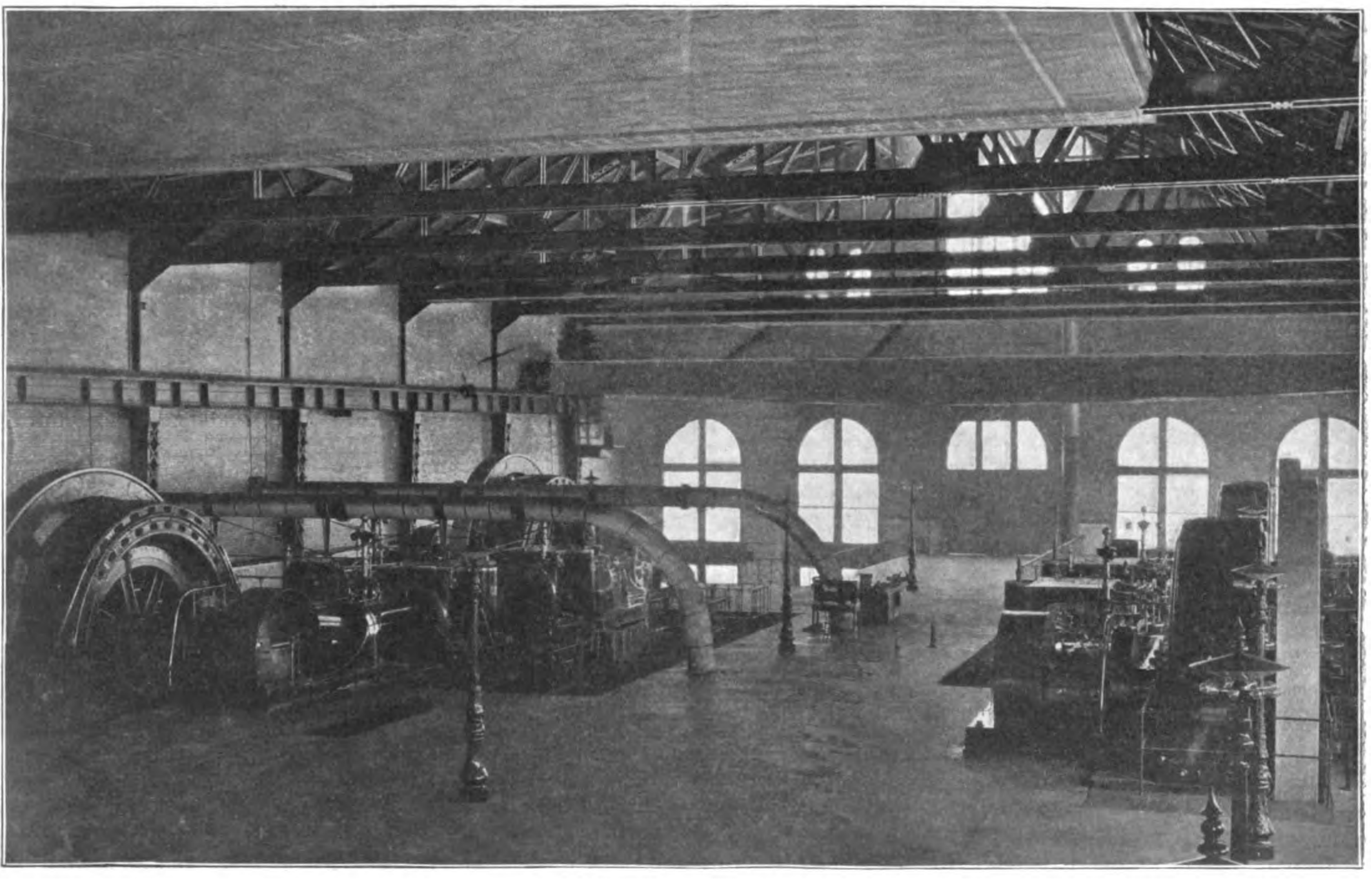


FIG. 2.—VIEW OF THE GOLD STREET ENGINE ROOM.

The main engines are cross-compound Reynolds-Corliss (E. P. Allis Company) machines, of 1000-h.p. capacity each; there are four of these, each driving direct a 750-kw. Westinghouse three-phase alterator at 94 r.p.m. Fig. 1 illustrates one of the engine-generating units. Fig. 3 gives a partial view of the valve-gear, which is of the familiar Reynolds type. The space which is nearly enclosed by the four cylinders of each pair of engines forms a sort of operating platform, containing a steam-chest, receiver and vacuum gauges for each engine, mounted on the generator frame, as shown in Fig. 3, and all of the manipulating valve-wheels; the latter are on floor-stands, as in marine practice. Each engine is equipped with a Monarch safety stop made by the Monarch Manufacturing Company, Waterbury, Conn., and an electro-mechanical synchronizing device. The safety stop consists simply of a fly-ball governor which closes a circuit through a magnet coil when the speed becomes excessive; a magnet armature which trips a latch and allows a heavy weight to close a stop-valve in the engine supply pipe, and an electric bell which is put in circuit by the same mechanism that closes the stop-valve. The synchronizing arrangement includes a Lundell motor mounted on the governor rod which connects the cut-off mechanism of the high and low pressure sides; this motor is controlled from the switchboard and is adapted to rotate the governor rod independently of the governor so as to vary the cut-off, and consequently the speed, of the engine.

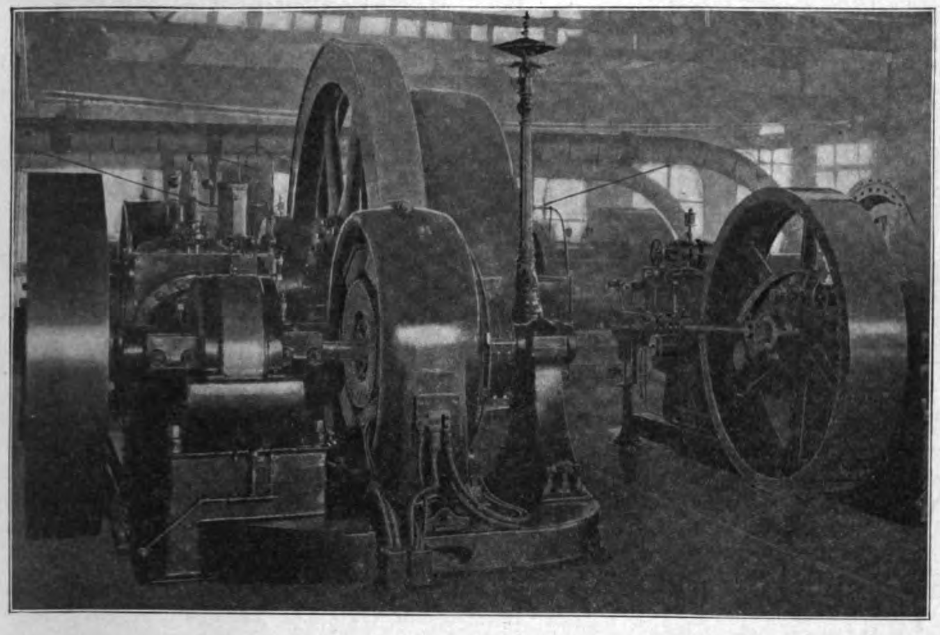


FIG. 4.—THE EXCITER SETS.

The four 750-kw. alternators are of the revolving-field type, with the rotating member built up on the engine shaft between the high-pressure and low-pressure cranks. They deliver three-phase currents directly to the line at 6600 volts and 25 cycles per second. The fields are excited by 125-volt Westinghouse dynamos each of 250 kw. capacity. These machines are standard lighting dynamos, with multipolar compound-wound fields and direct-driven by 400 h.p. Ball & Wood tandem-compound engines. The engines are equipped with the latest type of valve-gear. The exhaust valves are operated by an individual eccentric and wrist-plate motion, only the steam valves being affected by the action of the governor. The valves are of the rocking type and the gear gives them a peculiar quick-opening movement due to the change of angle between the rocker-arms on the valve-stems and the links which connect them with the wrist-plate. There are two of these exciter sets, each capable of supplying the fields of all four alternators. There is in process of installation an auxiliary storage battery of 8000 ampere-hours capacity, the function of which will be to prevent "loss of field" by the alternators in the event of having to shut down the active exciting set before its mate can be started up, when only one set is running. A motor-dynamo set has already been installed for use in connection with the storage battery. It comprises a Lundell dynamo of 50 volts and 100 amperes capacity and a Lundell motor of corresponding capacity; this set appears in the view of the switchboard, Fig. 5.

The switchboard is divided into ten panels, eight of which are in place; the other two will be installed immediately. There are four generator panels, one station panel, one exciter panel and two feeder panels now up; the two to be installed will be feeder panels. Three sets of 6600-volt bus-bars extend across the board, this number being provided for convenience in "changing over" generator sets. The station panel equipment consists of three General Electric Type F oil-break switches for tying the bus-bars together; synchronizing apparatus for synchronizing between bus-bars prior to "tying in"; a bus-bar voltmeter calibrated to indicate the line potential, and two static ground detectors. The generator panels contain each three Type F oil-break switches, one for each set of bus-bars; two G. E. induction indicating watt-

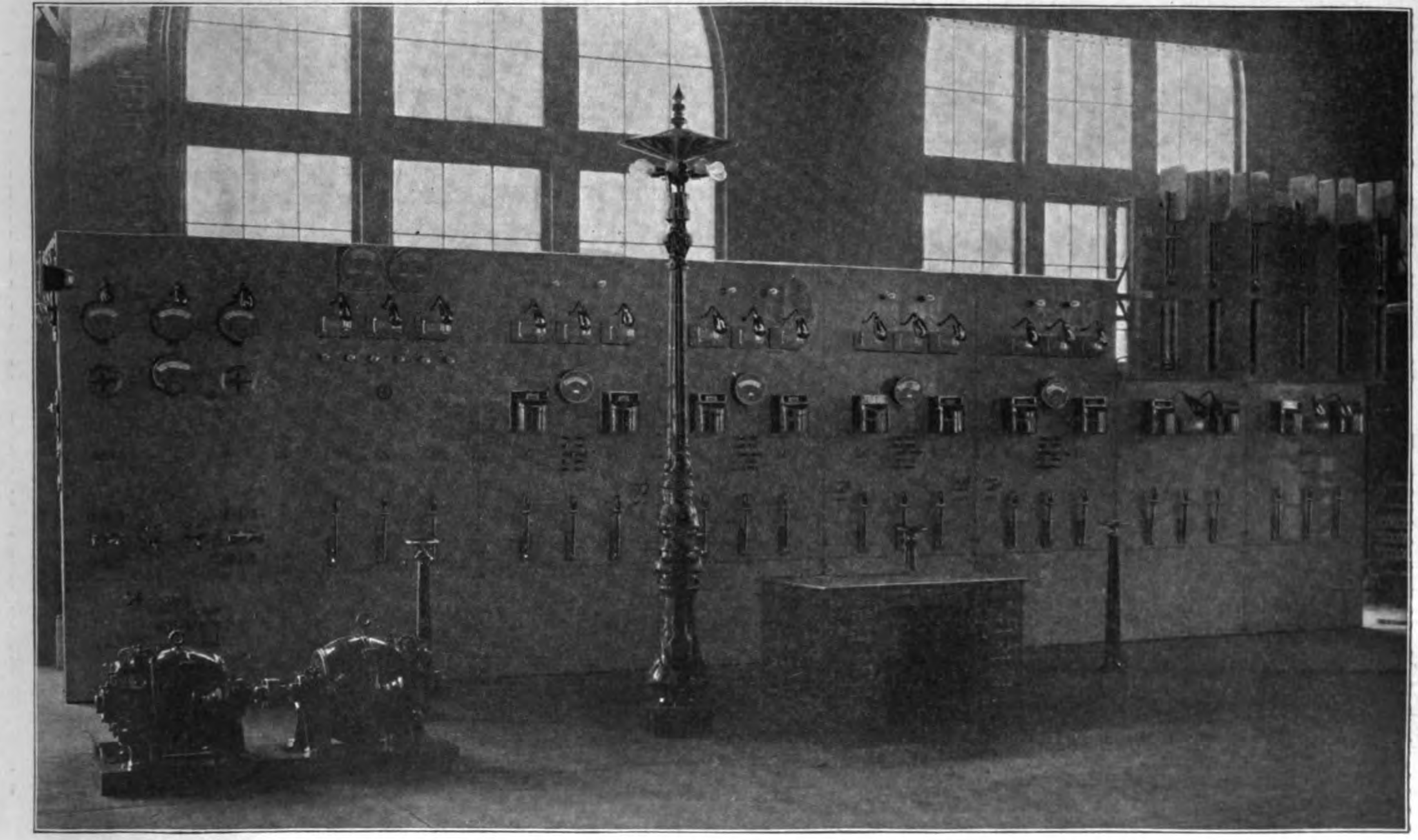


FIG. 5.—THE SWITCHBOARD OF THE GOLD STREET STATION.

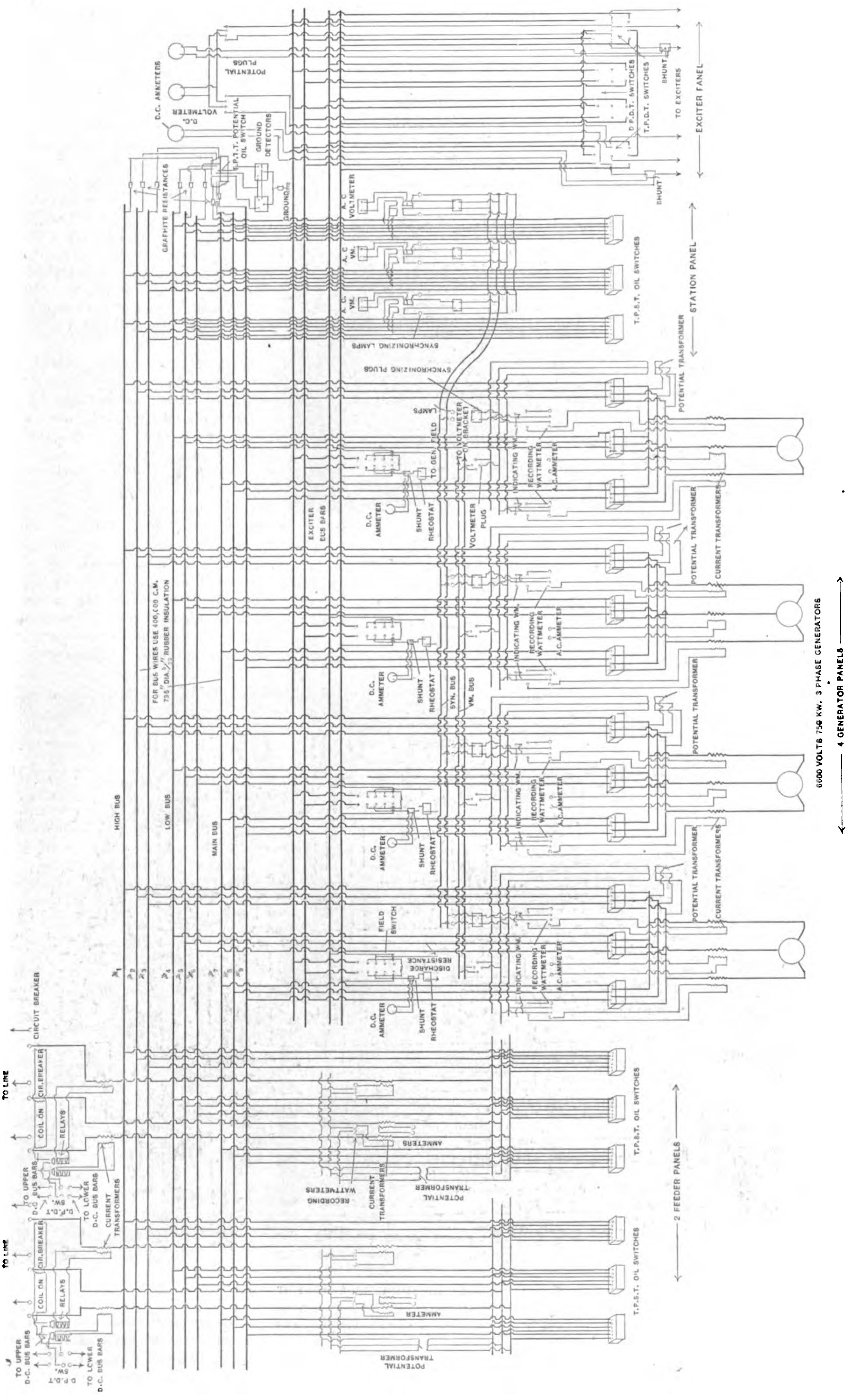


FIG. 6.—WIRING DIAGRAM OF THE GOLD STREET STATION SWITCHBOARD; FROM THE BACK OF THE BOARD.

meters; two Thomson recording watt-hour meters; a main ammeter; potential plugs and synchronizing apparatus; a field circuit switch and a Weston ammeter in the field circuit. The exciter panel carries the usual equipment of direct-current instruments and switches. The switching arrangement is such that any alternator field may be put on either of the exciters, and the latter may be operated in parallel or independently. Each feeder panel carries three Type F oil-break switches, one for each set of bus-bars; three circuit-breakers and two Thomson recording watt-hour meters. All of the switchboard equipment was manufactured by the General Electric Company excepting the direct-current voltmeters and ammeters, which were furnished by the Weston Instrument Company, Newark, N. J. The circuit-breakers are in compartments at the top of the panels, as shown in Fig. 5. The switches are all located beneath the engine-room floor and connected to the switch handles by means of long wooden rods, so that the attendants do not need to handle any apparatus that is metallically connected with the high-tension circuits. Before resetting a circuit-breaker the feeder is cut off by its oil-break switch.

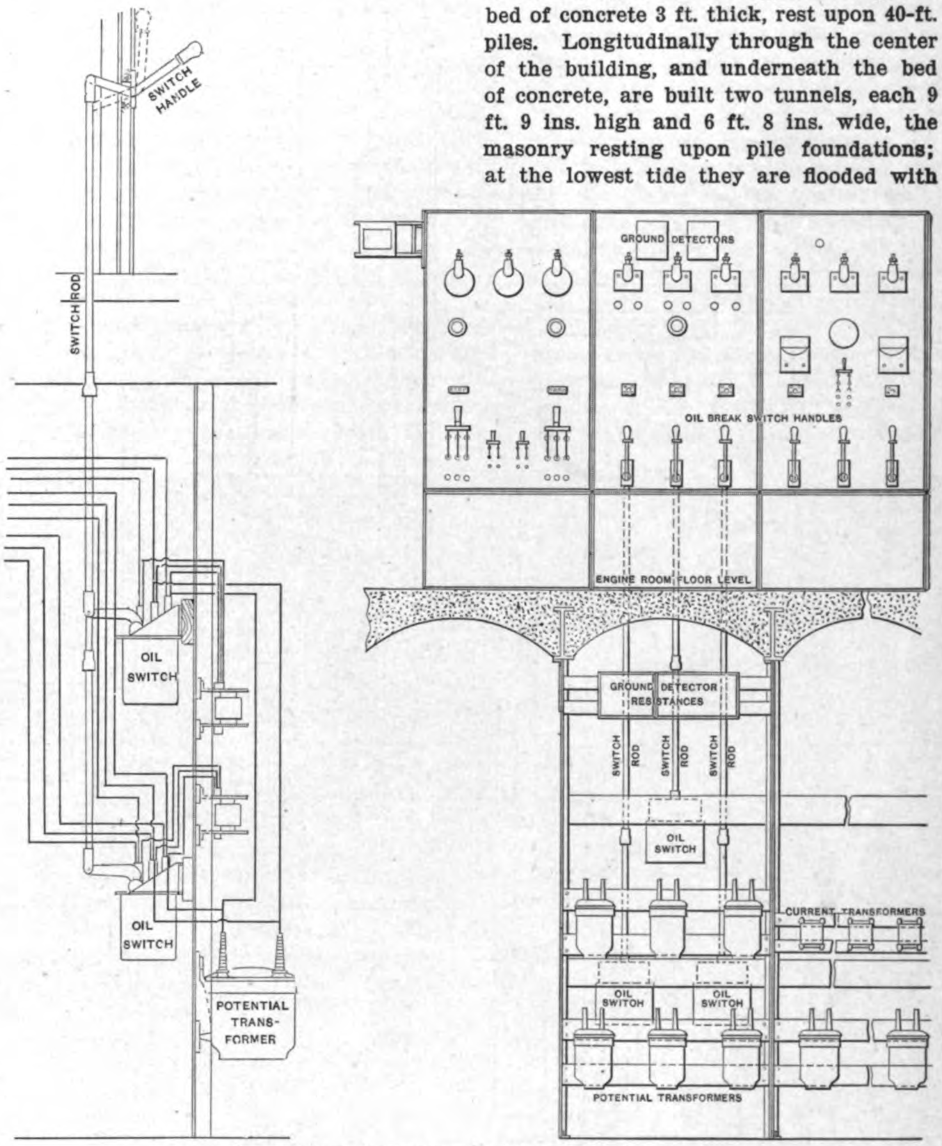


FIG. 7.—DETAILS OF HIGH-TENSION SWITCH MECHANISM.

The Bay Ridge station, or Union Station, is not yet complete. It contains at present twelve 500-h.p. water-tube boilers of the B. & W. type, built by the Aultman & Taylor Machinery Company, of Mansfield, Ohio; one McIntosh & Seymour twin tandem-compound engine of 2500-h.p. capacity; one Hamilton-Corliss cross-compound engine of 1200 horse-power, and two General Electric three-phase alternators, one of 1500 kw. and the other of 750-kw. output, with the necessary auxiliary machinery and apparatus. The station building is 206 ft. long and 120 ft. wide, of composite brick and iron construction. The foundations of the building, consisting of a bed of concrete 3 ft. thick, rest upon 40-ft. piles. Longitudinally through the center of the building, and underneath the bed of concrete, are built two tunnels, each 9 ft. 9 ins. high and 6 ft. 8 ins. wide, the masonry resting upon pile foundations; at the lowest tide they are flooded with 6 ft. of water. The tunnels extend out into New York Bay a distance of 50 ft. from the building, and at this point they are protected by heavy copper-wire screens. The purpose of these tunnels is to have water directly under each engine without requiring suction, the condenser pump of the engine taking the water from one tunnel, through the surface condenser, and discharging it into the other. This arrangement reduces the energy required for the circulation of the condensing water to that required to overcome the friction of the piping, the column of water that is discharged balancing the one that is lifted.

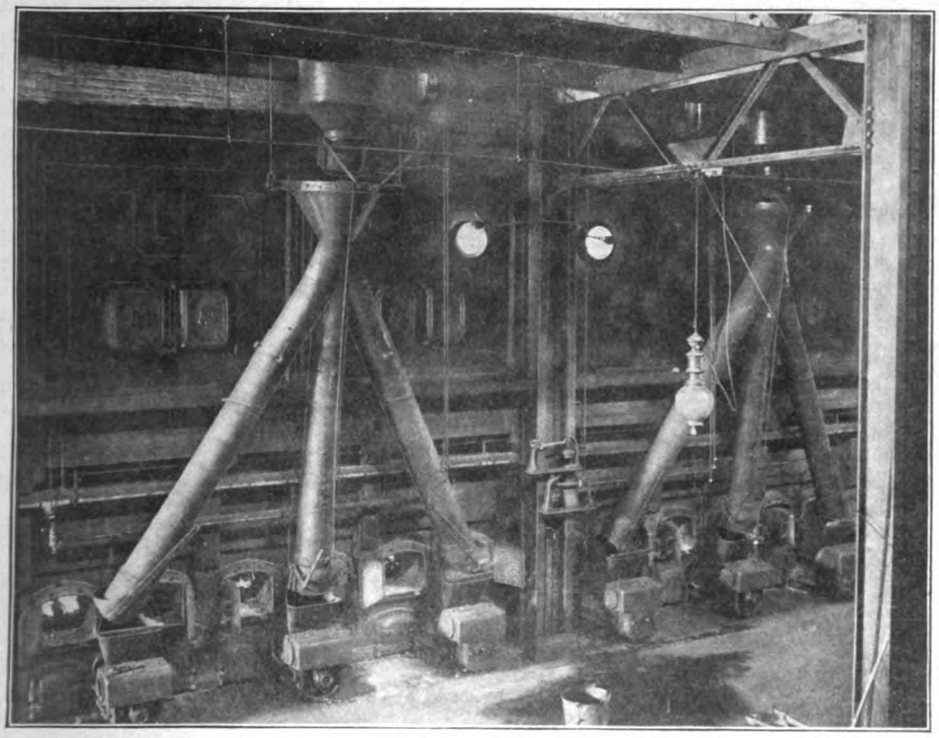


FIG. 8.—A PARTIAL VIEW OF THE BOILERS.

Extending out from the southern part of the water-front of the company is the coal pier, built to accommodate vessels of any length and draught. On this pier travels an unloading tower, which is operated entirely electrically by one man. The electric hoist, operated on the Leonard system, removes the coal from the boat on either side of the pier with a one-ton shovel and deposits it in a hopper in the center of the tower. The coal then falls by gravity onto the crushing rolls, which are driven continuously from a motor dynamo which supplies the hoist

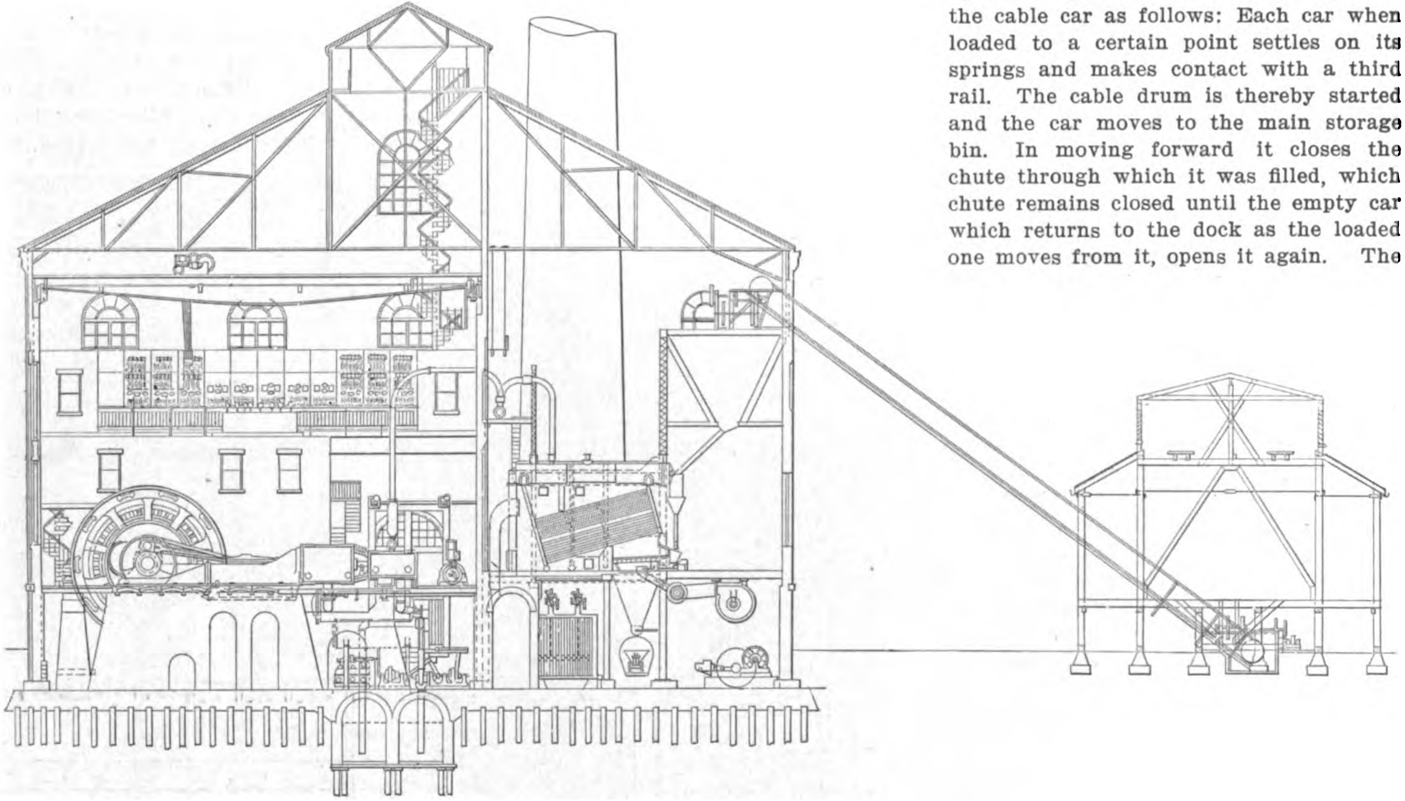


FIG. 9.—CROSS-SECTIONAL ELEVATION OF THE UNION STATION.

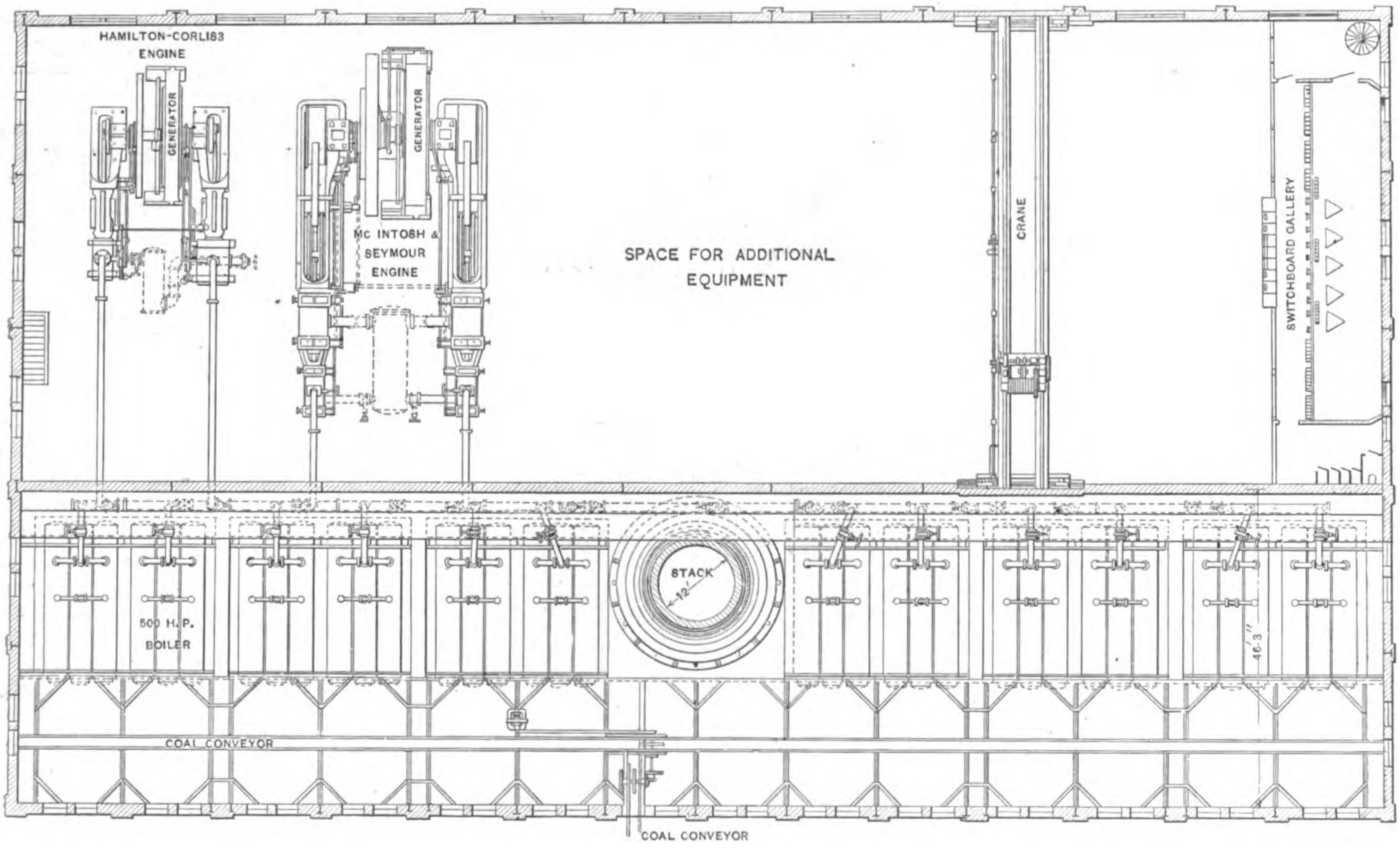


FIG. 10.—PLAN OF BOILER ROOM AND ENGINE ROOM AT UNION STATION.

above. From the crushers the coal passes to a Clarke self-weighing and self-feeding scale, which automatically records the weight of the coal on a dial. From the scale the coal descends into a cable car located beneath the tower and running on tracks laid on the pier.

The tower is capable of moving lengthwise to the pier, so as to render it possible to unload the coal at any point on either side of it. From the tower the coal is conveyed by means of a shuttle cable road up an incline to a 2000-ton coal storage bin, located about 300 ft. back of the tower and 60 ft. south of the main building. The motor operating this shuttle road is automatically stopped and started by the weight of the coal that drops into the cable car as follows: Each car when loaded to a certain point settles on its springs and makes contact with a third rail. The cable drum is thereby started and the car moves to the main storage bin. In moving forward it closes the chute through which it was filled, which chute remains closed until the empty car which returns to the dock as the loaded one moves from it, opens it again. The loaded car empties itself at any point desired; the car thus emptied is raised in its springs, breaks the circuit and is stopped.

The coal storage is a wooden structure 100 x 40 ft., and 30 ft. high, proportioned and built for the storing of 2000 tons of soft coal. Under the pocket, and for its entire length, runs a link-belt conveyor.

This conveyor takes the coal from the various chutes and deposits it into another conveyor, which, carrying it up an incline of 30°, transfers it to a third conveyor, which deposits it into hoppers over the boilers, which have a capacity for two days' supply. This arrangement is shown in the sectional view, Fig. 9. From these hoppers the coal passes down a chute and through a self-weighing scale (one for each battery of boilers) into a small distributing screw conveyor, which feeds it to the stokers. Thus the entire operation from the unloading of the coal on the tower to the burning of the coal in the furnace is performed automatically. The coal-unloading machinery was installed by John A. Mead & Co.

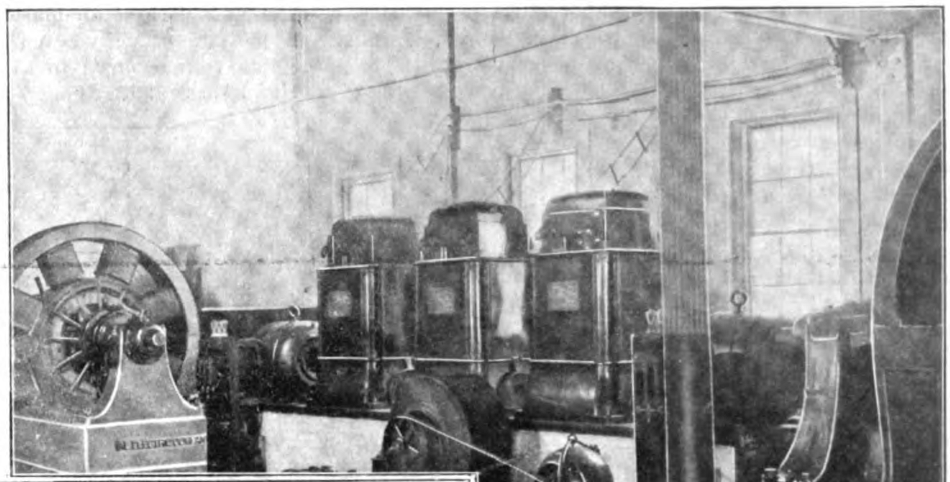


FIG. 12.—TRANSFORMERS AND ROTARIES.

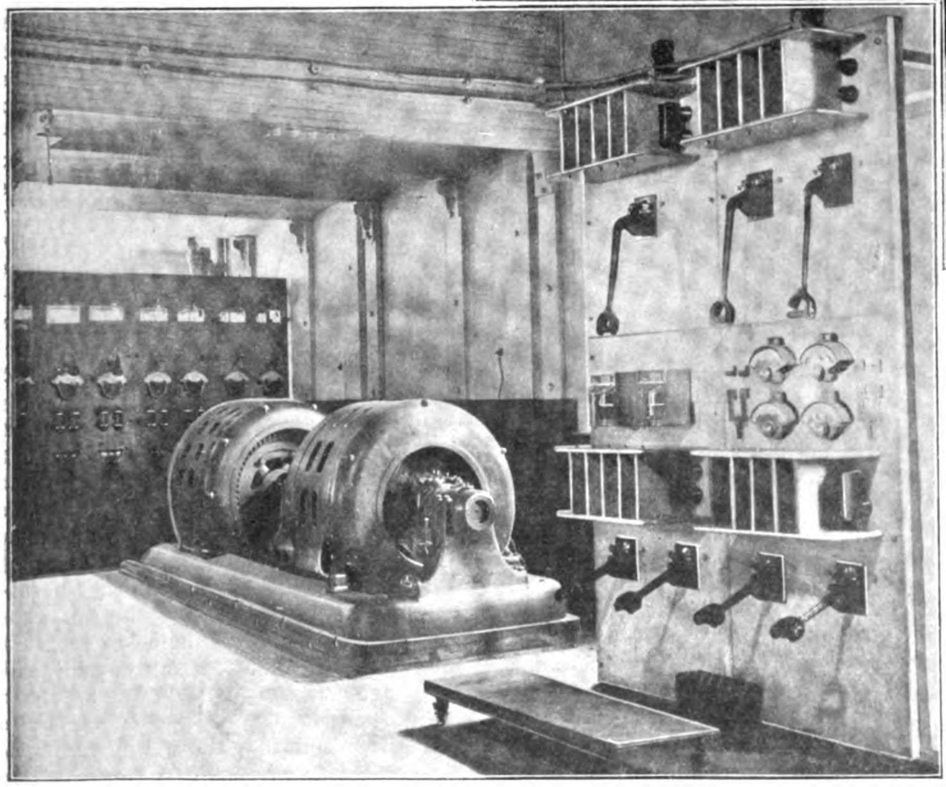


FIG. 11.—VIEW IN SECOND DISTRICT STATION.

Beneath the boiler room floor, and under the rear of the boilers, next to the firebrick flue, are located the Green economizers, so arranged as to provide for positive or natural circulation, as may be desired. The front of each economizer is fitted with a sectional sheet-iron filled cover so that any portion of the cover may be taken off and examination made of the sections of the economizer, and any section taken out without disturbing any other part of the economizer or disturbing the brickwork. These economizers were furnished by the Fuel Economizer Company, of Matteawan, N. Y.

In front of the economizers, and under the furnaces of the stokers, are placed the ash-receiving hoppers, beneath which runs an ash car the entire length of the boiler room, and through a bin in the west end of the building, to a point between two bulkheads, where the ashes are used for filling-in purposes.

Beneath the boiler room floor, directly under the passage of the front of the boilers, are placed the boiler-feed auxiliaries, blowers for the automatic stokers, and also the deep wells, used for the supplying of boiler feed water. In this station electric auxiliaries are used throughout. The circulating pumps are of the Knowles centrifugal type, direct-connected to a G. E. multipolar motor by insulated couplings, and run at a speed of 600 r.p.m. The air pumps are of the Worthington steeple three-plunger type, driven by means of single-reduction multipolar slow-speed G. E. motor, running at about 300 r.p.m Each group comprises a circulating and air pump, connected by short piping with a Worthington surface condenser, which is located immediately beneath the low-pressure cylinder, allowing, however, for suitable by-passes to free exhaust, and also for the introduction of a 2000-h.p. vertical Goubert heater, which is placed on either side of the engine in the basement The speed of these air and circulating pumps is controlled from the engine-room floor by means of field rheostats.

The total circulating water piping for each unit of 1500 horse-power does not exceed 12 ft. in length, there being but five joints. The total connection of the air-pump piping is about 14 ft. long. The total length of the piping between the low-pressure engine cylinder and the condensers, including the piping to the heaters for each unit, does not exceed 20 ft. in length, there being not more than seven joints. As will be seen from the above, special attention was paid to short connections.

The boiler feed pumps are of the Worthington horizontal three-plunger type, single-geared to a G. E. multipolar motor, running at 250 r.p.m. The speed of each unit is controlled from the boiler-room floor by means of a rheostat in the field circuit. Each boiler feed pump is directly connected to the feed system, which passes through Goubert heaters and auxiliaries into the main line, from which are taken the feeds to each boiler. Suitable by-passes are arranged for each piece of apparatus, so that any system of feed is provided for. The suctions of the feed pumps are connected to a main supplied from a number of driven wells, which are the chief source of water supply. The pumps draw from two large water tanks, where all particles of sand or suspended matter can settle. These tanks are supplied from the wells by an electrically-driven Deane duplex pump. Into the tanks are also connected all the leaders of the building, so that rain water can be used as boiler feed when desirable. Sturtevant blowers, which supply air to the stokers, are secured to the ceiling of the basement, or the underneath side of the boiler-room floor, and are directly connected by belts with slow-speed multipolar motors.

The plant, when completed, will contain

two 5000-h.p. Westinghouse-Allis engines, each driving a revolving-field Westinghouse three-phase alternator of 3000-kw. capacity; four Westinghouse synchronous 6600-volt motors of 225 horse-power each; two Westinghouse direct-current 125-volt excited dynamos of 150-kw. capacity each, direct-driven by two of the synchronous motors; two Westinghouse 250-volt direct-current dynamos of 150 kilowatts each, direct-driven by the other two synchronous motors and used to supply current to the motors which drive the pumps; and a switchboard embodying the latest practice of the General Electric Company.

As stated above, the three-phase 25-cycle currents are not used on any of the distribution mains, but are fed directly to the various sub-stations, of which there are eleven. The principal sub-station is what was formerly the central station of the old Citizens' Electric Illuminating Company. Here are located eight Brush arc dynamos direct-driven by four synchronous motors; a 400-kw. General Electric rotary converter, which supplies the outer wires of the three-wire incandescent system; a storage battery plant of 14,000 ampere-hours capacity which "floats" on the bus-bars of this system, and a 125-h.p. booster set for use in conjunction with the battery. The arc-lighting apparatus was described in the American Electrician for June, 1898, so that a detailed description here is not at all necessary. This sub-station serves also as a meeting-point for the main feeders from the Gold street and the Union stations; from its switchboard radiate feeders to other sub-stations, which feeders are thrown on either of the main generating stations according to controlling conditions.

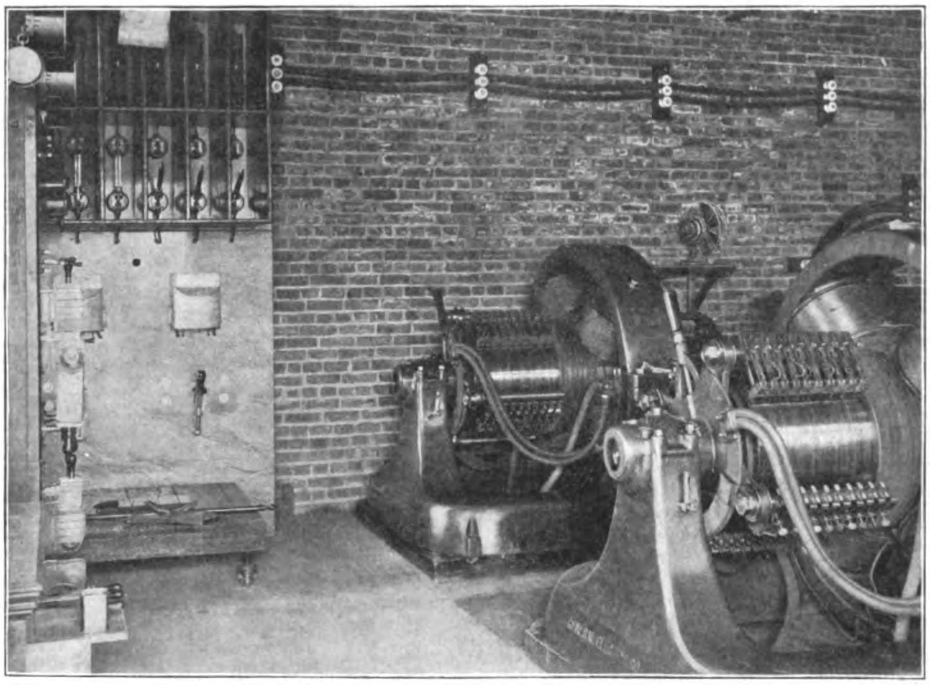


FIG. 13.—A COMPACT SUB-STATION.

There are three sub-stations from which two-phase primary circuits are supplied at 2400 volts and 62 cycles. These are the Second District, Coney Island and Forty-second Street stations. In all three, therefore, frequency changers are operated which change the generated currents not only from 25 to 62 cycles, but from 6600 to 2400 volts, and from three to two phases. Fig. 11 is a view in one corner of the Second District sub-station, in which the frequency changer appears. The machine consists of a synchronous 6000-volt motor of 100-kw. capacity direct-coupled to a machine which might be described as an induction motor with a 6000-volt three-phase stator and a two-phase 2400-volt rotor, the latter being provided with collector rings through which the two-phase primary circuits are supplied from the rotor winding. The synchronous motor drives the rotor in the opposite direction to that which it would take if allowed to run as a motor and the relation between the stator and rotor windings, of course, is such as to produce the change in frequency, phases and voltages. The capacity of the set is 200 kilowatts.

The switchboard which appears in the background of Fig. 11 is the 2400-volt board from which the two-phase primary distributing circuits are supplied.

To the right of the illustration is the 6000-volt switchboard, which is provided with the usual oil-break switches and instruments. From this board are supplied the frequency changer and three air-blast transformers of 150-kw. capacity each. These bring the line voltage down to 85 volts for use by two General Electric 25-cycle rotary converters, of 200-kw. output each. The transformers are supplied with air from a Buffalo blower-fan driven by a small General Electric direct-current motor. Between the rotary converters and the transformers are inserted induction regulators. Fig. 12 shows the transformers and converters. The direct-current brushes of the rotary converters feed into the three-wire incandescent mains at 125 volts, one converter supplying each side of the system.

Two of the sub-stations are of a somewhat novel character in that their sole purpose is the supply of current to private industrial establishment. One is located at the Worthington Pump Works and the other at Milliken Brothers' Structural Iron Works. Fig. 13 is a view in the Milliken station, which contains in the small space of 500 sq. ft. a complete 300-kw. power plant. The plant comprises two General Electric rotary converters and a Churchward converter of 100-kw. capacity each; three General Electric transformers of 30 kw. and three Wagner transformers of 75-kw. capacity each; and all the accessory apparatus. General Electric induction regulators are interposed between the transformers and the collector ring of the rotary converters, and there are the usual high-tension altenating-current and low-tension direct-current switchboards. The high-tension board faces the doorway and may be seen in the engraving; the edge of the direct-current board is toward the observer, so that it does not show plainly. The General Electric rotaries are four-pole machines and the Churchward converter has six poles; the frequency being 25 cycles, the speeds are 750 and 500 r.p.m., respectively. The direct-current e.m.f. is 250 volts, and the current is used to drive motors throughout the works. Among these are the motors on two huge cranes spanning the stock yards and railroad tracks, and the changes in load are consequently as erratic as in a small railway power house.

The feeders which connect the various sub-stations with the two generating stations are all underground, excepting those running down to the Coney Island Station. The feeders between the Union Station and Coney Island, and those from the Union Station to the Citizens' Station are quadruple; all of the others are in duplicate. The underground cables consist of three conductors each insulated with paper covering 3/16 in. thick and twisted together, the whole being again covered with paper to a depth of 3/16 in. and armored with lead ⅛ in. thick. The lead armoring is grounded permanently and the cables are run in vitrified conduits, each cable in an individual duct.

All three-phase energy entering a sub-station is measured by a recording wattmeter before it is distributed to the various transformer devices; all energy leaving a sub-station in any form whatever is also measured by wattmeter, as is also all energy used in a sub-station for lighting, heating, etc.; all energy generated and used at as well as that leaving the generating stations is metered, so that a complete record of the entire system is obtained.

It was not thought that the extra expense was justified to separately meter the energy entering the various transforming devices, as tests at frequent intervals will satisfactorily determine, mechanically and electrically, the efficiency. All business done by the company is on the meter basis.

RECENT TYPES OF BRITISH CENTRAL STATIONS.

THE CENTRAL STATION AT WEST HAM, LONDON.

English central stations are in many respects different from those in the United States, and one of the prominent points of variance is the heterogeneous nature of the plant. In most cases there are to be found generators by two or more makers, and other electrical apparatus gathered indiscriminately from many manufacturers, possibly with the intention of testing the merits of all in order to arrive at definite conclusions for future orders. It therefore results that British central stations have not that uniformity that characterizes our own, where more fortunate conditions of local government, as well as more definite demands for power, have enabled the installation to be proceeded with in a more complete manner from the start.

Foremost among the engineers associated with electric central station work in England is Sebastian Z. de Ferranti, who has been prominently connected with the development of electric light machinery and systems of distribution during the past decade. Although still a young man —he was born in 1864—Mr. Ferranti has had a life ripe in experience which has been turned to good account. In 1882 he was appointed engineer to a company formed to manufacture his dynamo with the wave-form coreless armature, which constituted an important step in the evolution of the practical machine of to-day, as these dynamos proved efficient and reliable, and capable of sustained service without fear of breakdown. In 1886 there were practically no large dynamos anywhere, certainly nothing of any importance; but Ferranti at one step went straight away to a 700-h.-p. high-tension generator, and followed this two years later by generators of 1600 horse-power capacity.

Many improvements in design were introduced in those early days, which have since proved their value by universal adoption; as, for instance, the use of copper strip wound on edge for the field coils. Later, this method of winding coils was applied to meters, and in 1893 to high-tension alternator fields. About this time Mr. Ferranti sent sample coils to Messrs. Brown, Boveri & Co., who adopted the idea, and strips wound on edge are now universally employed in the United States and all over Europe.

The first central station work with which Ferranti was connected was the first station of importance in operation in England—that built in the sub-basement of the Grosvenor Gallery in London, and equipped with three Siemens alternators of the wood-core bobbin type. The distribution was by means of Gaulard and Gibbs series transformers. The many difficulties incidental to the operation of a high-tension central station called for an experienced engineer to direct the work, and Mr. Ferranti undertook the responsible task of bringing the system to a commercial and practical basis.

Much trouble was experienced with the alternators, as they were of rather primitive design, and eventually the three were replaced by one Ferranti alternator of 700 horse-power, the armature being carried on the countershaft and the magnet frame placed on a baseplate sunk in the floor, with extension plates to allow of the frame, which was in halves, being slid away from the armature for purposes of inspection. This construction is now employed in nearly all large machines of the present day. The station was later supplied with a self-contained unit of 700 horse-power, with grooved pulley for rope driving, and an outboard bearing. Still later, it was decided to start the supply of current on a larger scale, and Mr. Ferranti determined on a radical departure from existing procedure by drawing up

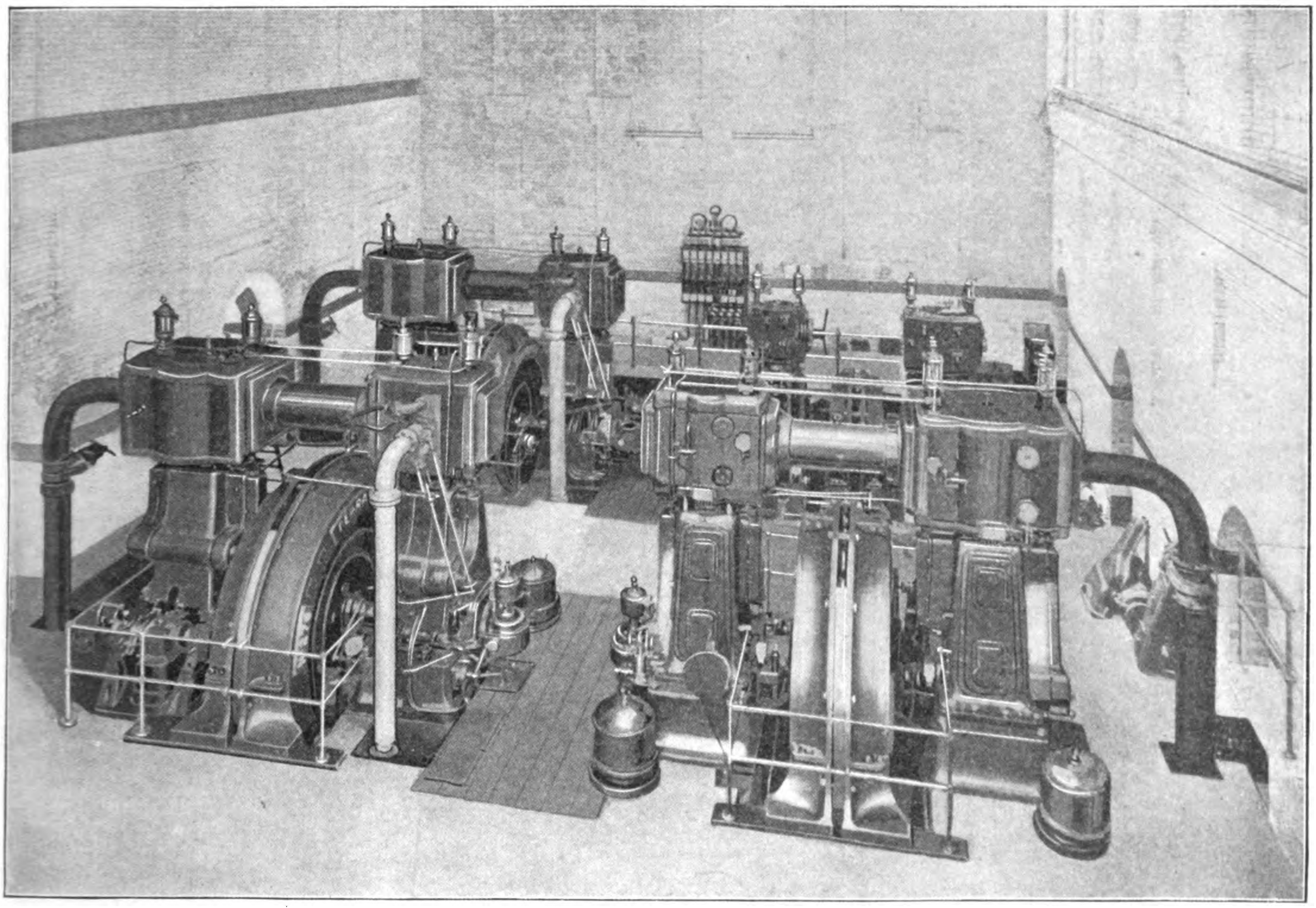


FIG. 1.—VIEW OF SMALLER GENERATING SETS, TAKEN FROM THE ENGINE-ROOM CRANE.

plans for a station of enormous capacity, which should be able to supply current for lighting on the same scale as the large gas corporations.

The Grosvenor Gallery high-tension distribution was at 2400 volts, but the new station, at Deptford, eight miles away, was to supply a 10,000-volt distributing system, an unheard-of proposition, and, to most engineers of that day, preposterous. The plan was widely denounced and its failure almost universally predicted, but Ferranti persisted and brought to a successful consummation the enterprise so freely criticised, and the 10,000-volt distribution is still an accomplished fact, the current being carried in the special concentric cables designed by him for this station. Ferranti alternators of 10,000 horse-power were under construction for this station, and well advanced, in 1889; but the directors, losing faith in the scheme on account of its mammoth scale, decided that they should not be completed.

The borough of West Ham, in London, possesses a central station in which the running machinery, both engines and alternators, were designed by Mr. Ferranti and built by his firm. The most interesting part of the installation is the new type of large high-speed vertical compound engine which Mr. Ferranti has built on new lines and containing many original ideas which involve departures from ordinary practice. On the continent of Europe and in the United States high economy has usually been obtained by the use of low-speed Corliss or other form of trip-valve engines. In England, on the other hand, most of the electric lighting work has been done by means of small high-speed engines entirely enclosed, and running with but very slight wear, almost without attention. Mr. Ferranti has combined to a great extent the advantages and strong points of both systems in the engines which are in use at the West Ham station.

There are in this station six direct-connected engine-alternators; a small one of 200 horse-power, three of 400 horse-power each, and two of 2000 nominal horse-power each, but capable of furnishing 2500 horse-power. One of the striking features of the latter machines is the small amount of space occupied; the ground area is only 20 feet by 16 feet, and the height above the engine room floor is 17 feet. This, of course, involves high rotative speed, and the engines run at 250 r.p.m.

The alternator armature has the coreless strip winding, such as was used in the Deptford machines; or, rather, there is a core in the coils, but not of magnetic material, being built up of bronze strips cast into a shoe at the inner end and insulated by strips of asbestos to prevent the circulation of eddy currents. The diameter of the armature is 14 feet, so that the peripheral velocity is 11,000 feet per minute—a speed that most dynamo builders would not care to deal with—and, standing near it, it seems like a great buzzsaw turning within a circular guard frame. Both of these engine-generator sets are shown by Fig. 2.

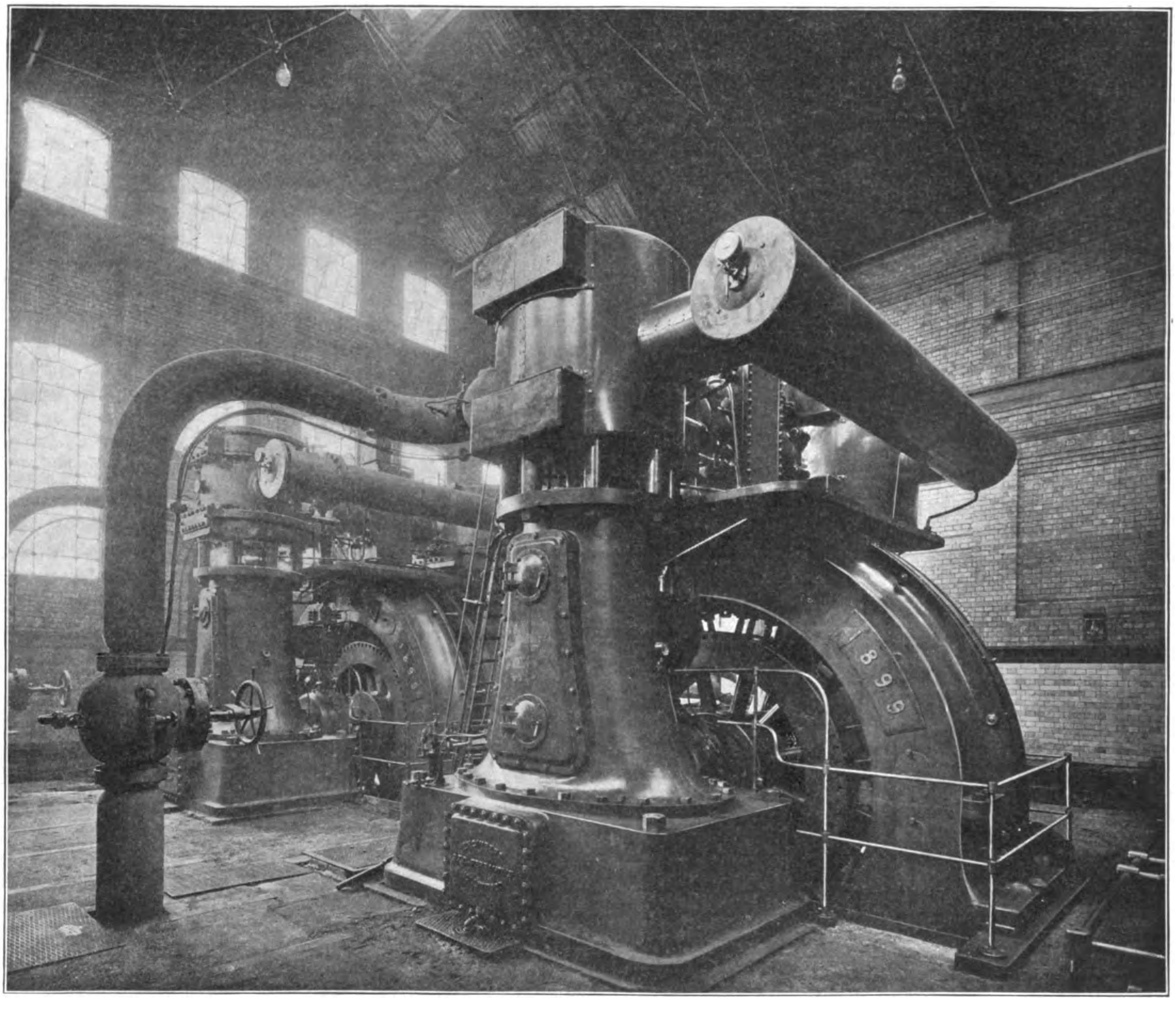


FIG. 2.—FERRANTI 2000-HORSE-POWER CROSS-COMPOUND ENGINES AND ALTERNATORS.

A radical change from ordinary designs is seen in the arrangement of the valve gear, which is enclosed in a chamber situated between the high and low pressure cylinders. No eccentrics are used for the valves, which are worked from a vertical shaft driven by bevél gear from the main shaft. This vertical shaft drives the exciter, which is a small bipolar Parker machine running at 750 r.p.m. A reduction of speed is made through a worm in the valve gear chamber, and the valves are moved by cams on a shaft which runs at one-half the speed of the engine. The whole of the valve gear is fitted in the valve box between the two cylinders of the engine. The box is closed by means of doors bolted and jointed in position, this construction enabling the valve gear to be entirely immersed in oil by filling the box containing it. This also acts as a reservoir for supplying the pumps which feed a relay governor with oil under pressure.

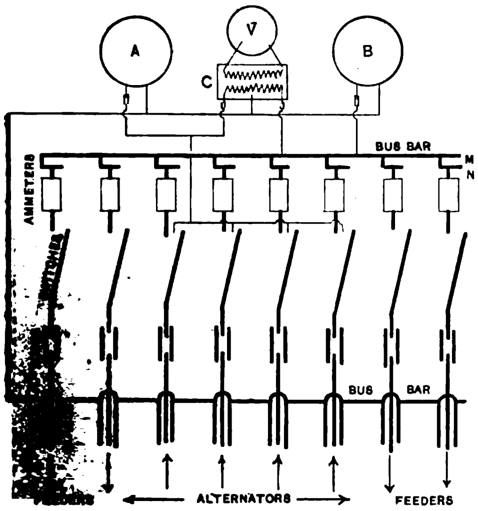


FIG. 3.—SWITCHBOARD DIAGRAM.

There are four valves to each cylinder, giving small clearance spaces. The valves are of the grid-iron type, and have double admission ports for travel in each direction. The exhaust valves have continuous travel, coming to rest at the end of the stroke, but the admission valves come to rest in the middle of each stroke, in which position the steam is cut off. A positive motion is given to the valve stems through rollers pressing against opposite sides of cams, where they are held in continual and firm contact. The cams are of constant diameter, and a variable motion of the valve is obtained by employing two cams, one fixed and one adjustable, whose relative position may be changed by the action of the governor. Variable expansion is used for both high and low-pressure cylinders. The connection of the valves is made by adjustable links, visible in Fig. 1, so that the valves may be very easily set, and if it is necessary to remove one of the cylinders, this may be done without interfering with the valve gear.

The speed of travel of both sets of valves is exceptionally low, notwithstanding the high speed of the engine; the maximum movement in each direction is only ⅝ inch, or 1¼ inches per revolution, giving a surface speed of 26 feet per minute. The engine may therefore be used with superheated steam, as is done at West Ham, where the working pressure is 160 pounds, and at the central station at Lambeth, where 200-pound superheated steam is used.

The speed of the engine is regulated very closely by a new form of relay governor acting on a spiral thread sleeve which varies the position of the movable cams relatively to the fixed cams on the vertical valve gear shafts. An emergency governor is also provided, which, in the event of an excessive rise in speed, will cut off the steam by a throttle valve. This governor acts through a lever on a movable fulcrum, and the valve may be closed by hand, should occasion arise, by pulling down the lever at this fulcrum.

Below the engine base on either side are oil reservoirs of enameled cast-iron, about three feet deep, the enamel being used in preference to having a metal surface on account of its communicating no impurities to the oil. Valveless rocking pumps on extensions of the crankpin force the oil through cloth filters in closed chambers in the engine base, then through oil pipes to the crankpins, main bearings, crosshead and slides, and the vertical valve gear shaft, providing forced lubrication to all running parts. The oil reservoirs are provided with cooling coils, through which cold water circulates, thus providing the bearings with a plentiful supply of clean, cold oil which contributes much toward the smooth running of the engine.

A special feature of the engine is the use of spherical self-adjusting bearings on cross-heads, crankpins and main bearings. The isolation of the valve gear serves not only to facilitate the erecting of the cylinders and pistons, but also the very practical end of keeping the gear and the oil in which it runs cool. The same idea is carried out in the lower part of the engine, for the columns are connected to the cylinders by short steel pillars which allow a free circulation of air beneath the cylinders and prevent the heat being transmitted to the columns and guides. Double glands are used, fitted with metallic packing, one on the under cylinder-head and the other on the top of the column, this arrangement being used to prevent the creeping through of oil or water. The columns entirely enclose the cranks and connecting rods.

The cylinder diameters are 28 inches and 51 inches, respectively, with a stroke of 21 inches. The combined efficiency of this engine-alternator set is between 86 and 87 per cent.

The alternator is in some points a departure from the more usual form heretofore seen, as special provision must be made for the very high speed at which it is driven. A heavy steel ring is pressed on the shaft over a split cast-iron hub, and steel radical bolts support the rim, which is in one piece and of cast iron. The bobbins in their bronze cradles are held by steel bolts insulated with sulphur. The armature is wound with copper strip ¾ inch wide, and the total air gap is 1½ inches, giving a clearance of ⅝ inch on each side between armature and pole-face. The e.m.f. of 2000 volts requires extra protection against sparking across, which is afforded by micanite caps covering the pole faces and extending a short distance back over the winding; this construction has been used for the last ten years on the 10,000-volt machines. The magnet frame may be moved back from the armature by means of screws, and runs over rollers in a cage on the base-plate. There are 24 poles on either side, giving, at 250 revolutions a minute, a frequency of 50 cycles.

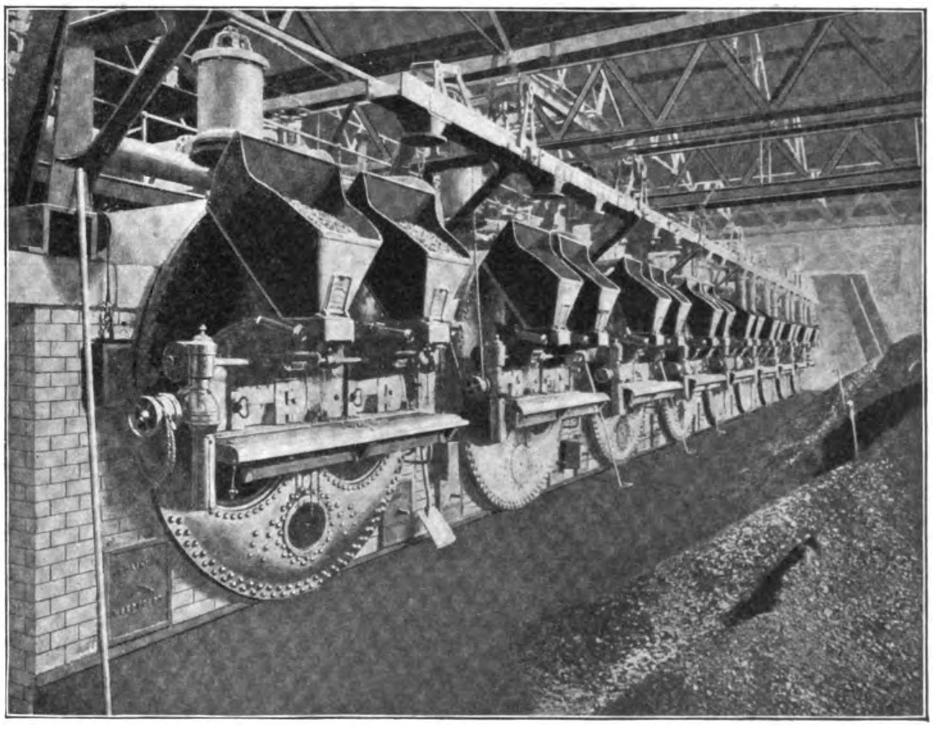


FIG. 4.—LANCASHIRE BOILERS AT WEST HAM STATION.

The West Ham electric light station

is before long to be removed to a new site near the river, where coal and water will be cheaper. It is at present located in one-half of a sewage pumping station, and the contrast is remarkable in passing from the powerful, high-speed Ferranti engines to a couple of pumping machines in the next room.

The switchboard is of the well-known Ferranti type, the instruments and switches being separated by a series of enameled slate partitions. Concentric cables are used for all circuits of distribution, with the outer main grounded; single-pole switches for the inner conductor are used on the board. These switches have double knife-blade contacts and a rapid oil-break. Below them are oil-break fuses in porcelain partitioned boxes, where the fuse is held under slight spring tension. When an overload causes a fuse to blow, the ends are immediately immersed in the oil, one on each side of the partition, effectually preventing any arcing. In order to renew the fuse, the box is withdrawn from the switchboard contacts.

Below the row of fuses are the handles of the resistance boxes for the exciter circuits, and a special form of switch for opening the alternator field circuits, short-circuiting them first across carbon contacts to prevent burning due to the field flash. Each generator and feeder circuit has an edgewise Ferranti ammeter at the upper part of the panel, and on the top are the bus-bars for the inner conductor of the cables. On a shelf of slate above the board are mounted the synchronizers and high-tension voltmeters, all being clearly indicated in the accompanying diagram, Fig. 3.

In the center of the switchboard is a double switch for the purpose of connecting the switchboard into one complete system, or by disconecting, to make two independent boards, as may be advisable when the load is heavy. When work is being done on a generator or circuit, the corresponding panel is locked in such a way that the switch cannot be closed, and the foreman in charge of the work can keep possession of the key until he is ready for the current to be switched on. An ingenious attachment to the main switch allows of placing it on a synchronizer contact before closing it on the alternator circuit, and, as soon as synchronism is attained, the switch may be pressed home.

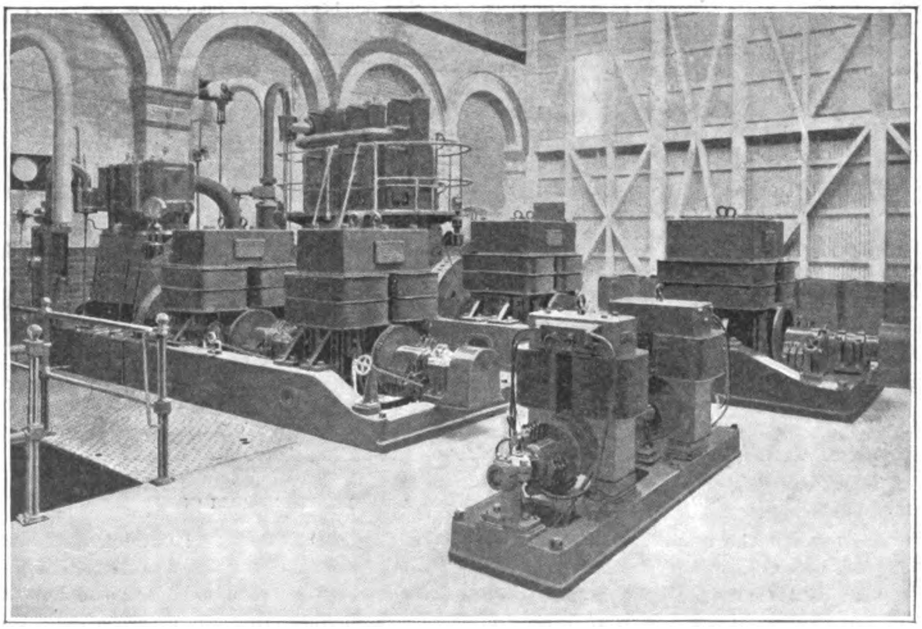


FIG. 5.—GENERATING ROOM OF THE GLOUCESTER MUNICIPAL STATION.

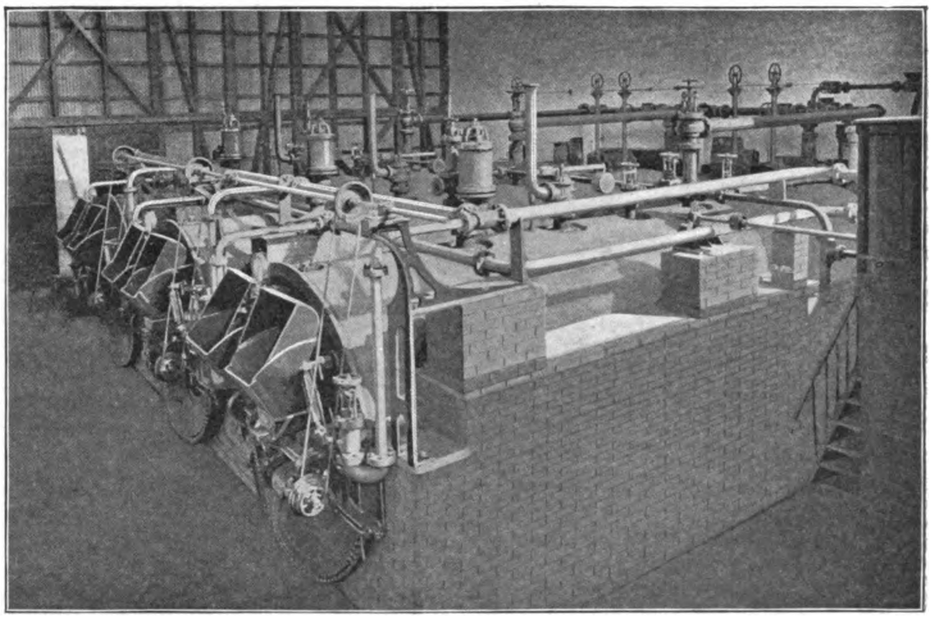


FIG. 6.—BOILERS OF THE GLOUCESTER MUNICIPAL STATION.

From the nature of the installation it is hardly possible to consider the boiler room and pumps altogether as part of the electric light station, since it was built as a combined pumping and lighting station, and the boilers and electric plant were added to as demand arose. At present there is 5400 horse-power of engines in use for electric lighting. At first nine Lancashire boilers of 300 horse-power each were put in, but Babcock & Wilcox water-tube boilers have been added to the plant. Fig. 4 is a view of the end of the boiler room containing the Lancashire boilers. They are fitted with mechanical stokers and a complete coal handling system.

The engines and electrical equipment of the station are thoroughly modern, and when they are removed to the new building they will have more fitting surroundings. There has not been much arc lighting done as yet, but a new departure is now being made in the addition of a Ferranti rectifier, which will probably soon be followed by several more of the same capacity—of fifty 12-ampere arc lights. General Electric alternating-current enclosed lamps were used, but the new system will have Brockle-Pell lamps and Ferranti rectifiers.

Features of Some Other English Plants.

At the Gloucester municipal station the boiler plant is similar to the old portion of the West Ham boiler plant. It consists of four Lancashire boilers, each capable of evaporating 6000 lbs. of water an hour. The boilers are 30 ft. long by 8 ft. in diameter, and the shells are built in seven sections of 13/16-in. plate. Fig. 6 gives a view in this boiler room. The boilers are fitted with Proctor mechanical stokers.

The generating plant consists of two engine-generator units, the engine of one set being of 500 h.p. capacity, and that of the other set being half this size. The larger engine drives two bipolar Silvertown dynamos, each capable of an output of 150 kw. at any e.m.f. between 440 and 500 volts, measured from outside to outside of the set—220 to 250 volts for each machine. The dynamos are shunt-wound with drum bar-wound armatures. The engine is a triple-expansion Belliss, with one high-pressure and two intermediate cylinders mounted above three low-pressure cylinders, and driving three cranks set 120° apart. It runs at 350 r.p.m. and is designed for 160 lbs. initial steam pressure. The smaller engine is a two-crank compound engine with one high-pressure and one low-pressure cylinder, driving cranks set at 180° apart. A single piston valve, located between the two cylinders, serves both of them. This engine will develop 250 horse-power at 380 r.p.m. under 130 lbs. steam pressure. It is direct-coupled to two Silvertown bipolar dynamos of 75-kw. output each, and these two, like the two larger machines, will give their rated output at any e.m.f. between 440 and 500 volts total, or 220-250 volts each. The engines were built by Belliss & Morcom, Limited, of Birmingham, which firm builds a large proportion of the central-station engines used in Great Britain. The engines are lubricated by a system of forced oil supply. Both of them run condensing, Blake & Knowles jet condensers being used.

The generators are supplemented by a storage-battery plant of 800 ampere-hours capacity, figured at a discharge rate of 80 amperes. There are 280 cells, and these are "floated" on the system, being charged during the light-load hours and assisting the dynamos during the heavy-load period. A booster set of the usual form is used in conjunction with the battery. This consists of a bipolar motor driving a dynamo of similar construction at 780 r.p.m.; the dynamo capacity is 100 amperes and 20 to 140 volts, and the motor takes current from the bus-bars at 220 to 250 volts.

The distribution is on the three-wire plan with 220 volts between the neutral and each outer wire. The feeders are underground cables laid in square cast-iron troughs, on wooden bridges, which are spaced at intervals of about 12 ins. After the cables are in place the trough is filled with bitumen, entirely enclosing them. Alongside of each feeder a small pilot lead-armored cable is laid directly in the earth; this serves to connect the feeding point with the voltmeter on the main switchboard at the station. The distributing wires are triple-concentric lead-sheathed cables, and these are laid in troughs like the feeders and surrounded by bitumen.

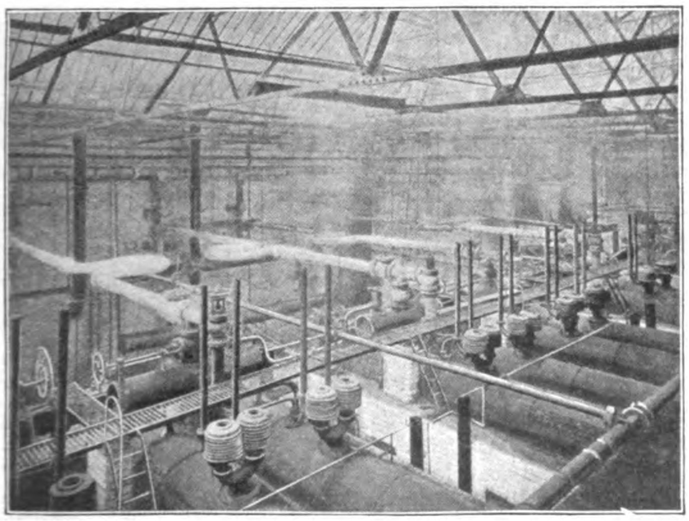


FIG. 7.—BOILERS IN THE GLASGOW STATION.

The arc lamps used for street lighting are grouped principally in series of nine across the outer wires of the system, a few groups of four lamps between the neutral and an outer wire being used. The lamps are of the Brockie-Pell single-carbon type, hung from ornamental goose-neck posts and arranged to be lowered for trimming and repairs by means of a winch in the base of the post.

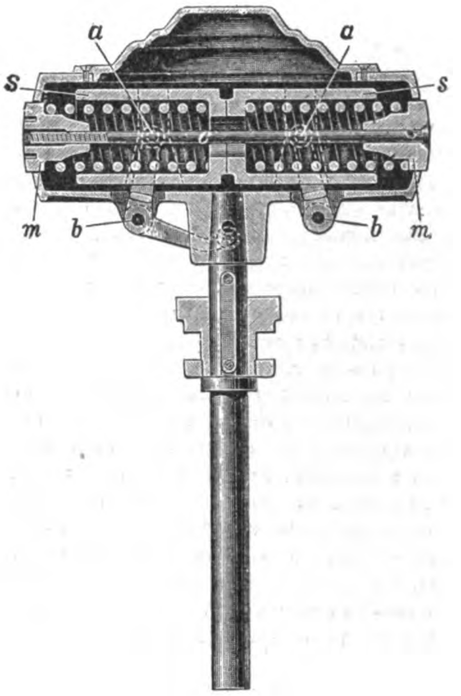


FIG. 1.—DETAILS OF HARTUNG GOVERNOR.

A feature of the plant is a garbage destructor provided for utilizing the refuse of the city as fuel. The garbage will not, of course, supply sufficient fuel to run the plant, but it serves to greatly lessen the coal consumption by supplementing the coal-fed boilers. This destructor has a capacity of 50 tons per day of 24 hours and is mounted under a Lancashire boiler 30 ft. long and 8 ft. 6 ins. in diameter.

The municipal plant of the city of Glasgow embodies a good many features of American practice and also retains a number of typically English features. In the engine room are found two Walker dynamos direct-coupled to a Ball & Wood vertical cross-compound engine; a Schuckert multipolar dynamo direct-driven by a Matthew Paul & Co. marine-type triple-expansion engine; two bipolar Crompton dynamos, of the same general type as the Silvertown machines in the Gloucester plant, direct-driven by single-acting vertical engines, similar in appearance to the Belliss engine; and two British Thomson-Houston multipolar dynamos of the circular-yoke type, driven by triple-expansion three-crank Belliss engines. The boiler room is equipped with Babcock & Wilcox boilers provided with chain-grate stokers. Fig. 7 is a view taken across the tops of the boilers and showing the arrangement of the steam pipes between the individual boilers and the horizontal header on the boiler-room wall. The engine room of this plant is a fair indication of the progress from the once-universal English practice of using bipolar direct-current machines toward the later American practice of using multipolar machines with circular yokes and radial magnet poles. It also illustrates the peculiar British custom of assembling in one engine room an aggregation of conglomerate types of engines and generators, which was referred to in the opening paragraph of this article.

A TYPICAL EUROPEAN ENGINE GOVERNOR.

Among other interesting engine parts shown at the recent Paris Exposition was the Hartung engine governor, illustrated by Figs. 1 and 2. As the illustrations show, the governor is very simple in construction. The weights, S and S, Fig. 1, are thrown outward by a centrifugal force against the resistance of the spiral springs shown in both engravings. The weights are connected by bell cranks, B and B, which support the weights in their position. A single adjustment nut, M, suffices to vary the tension of both of the governor springs as the rod, C, extends through the center of both springs and weights and terminates in a head similar in contour to the nut, M. Neither the weights nor the springs are attached in any way to the casing which surrounds them. The head of the nut and the extension head of the bolt fit rather snugly in circular openings in the wall of the casing, as indicated in Fig. 1, and these openings form guides for the springs, which prevent tilting. The governor is made by Herman Hartung, of Dusseldorf.

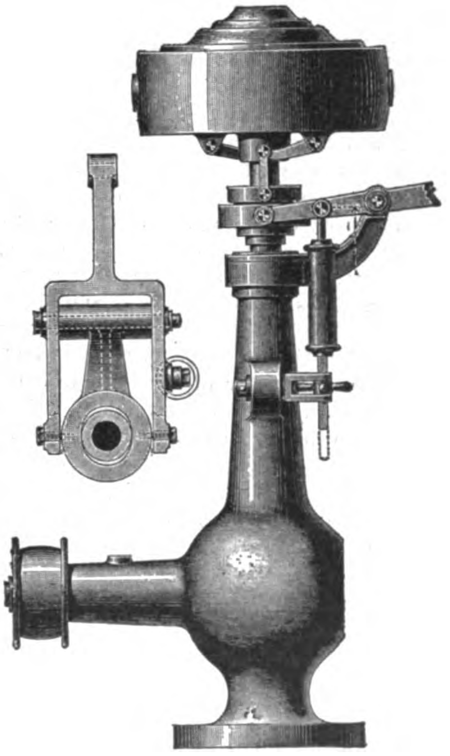


FIG. 2.—HARTUNG ENGINE GOVERNOR.

ELECTRICAL AND STEAM ENGINEERING IN THE NINETEENTH AND TWENTIETH CENTURIES.

ELECTRICITY IN THE NINETEENTH AND TWENTIETH CENTURIES.

BY A. E. KENNELLY, SC. D.

Standing within the portals of the twentieth century, and surrounded by electrical applications which have become a very necessity of modern civilized life, it is difficult to realize the condition of the electrical arts and sciences at the beginning of the nineteenth century. In the year 1801 there was not a single electric art, nor any utilization of this ever-present natural force. Franklin's lightning rod was certainly in use, but this was a device for preventing rather than utilizing electrical effects.

The eighteenth century developed the frictional electrical machine and a knowledge of the phenomena of high-tension electricity. In fact, comparatively little improvement has taken place in this direction during the nineteenth century. The frictional machines have made scarcely any advance in that time, and although the influence machines have improved in various ways, yet the improvement has been in degree rather than in kind, for Volta's electrophorous dates from 1775, and the influence machine was known in a variety of forms at the beginning of the nineteenth century.

In a similar manner, the science of electricity was practically circumscribed in 1801 to a summary of facts concerning high-tension electricity, and machines for producing it. Electrical measurements or quantitative relations were almost unknown. This was a condition consequent upon the intricate and recondite phenomena of high-tension electricity, apart from the limited number of students who expended efforts upon their study. It is doubtful whether in this year of 1901 we should possess any electrical measurements or any extensive quantitative knowledge concerning electricity if the voltaic pile had not been discovered. The difficulties in connection with the insulation, canalization and uniform supply of high-tension electricity are even now so great, that electrical measurements in connection with frictional or influence machines are vague, difficult and uninteresting. If all the electrical apparatus of Europe and America up to the end of the eighteenth century were collected together, we should be compelled to regard the collection from our present standpoint as an aggregation of interesting scientific toys, suitable for consoling the leisure and stimulating the imagination of secluded philosophers. Meanwhile, the average individual citizen of the eighteenth centnry regards electricity as a thing of danger, to be exorcised and avoided, which ran riot in thunder storms and was an uncanny spirit to be evoked by the magical power of wizard philosophers.

The complete revolution of popular feeling in the course of the nineteenth century which has made every modern citizen regard electricity as the force upon which he depends for the communication of intelligence from a distance and for the transmission of mechanical power from a distance, has been brought about in the main by two fundamental discoveries, namely, the voltaic cell in 1800 and the induction apparatus of Faraday in 1831. The electrical development of the nineteenth century is virtually an exposition of the development and use of these two instruments. Just as the eighteenth century may, from an electrical standpoint, be regarded as the era of development of high-tension electricity from the frictional machine, so the nineteenth century may be similarly regarded as the era of development of low-tension electricity from the voltaic cell and dynamo machine.

The voltaic cell gave an entirely new direction and motive to electrical investigation; it introduced a completely new set of ideas and a new terminology. The electric current was a conception which the spasmodic discharge of frictional machines and Leyden jars did not invite. It was, on the other hand, the natural suggestion of the phenomena attending the closure of the voltaic cell's electrical circuit. Upon the heels of the electric current came the electromagnet and electromagnetism, an instrument and a science which the frictional electric machine was not likely to reveal. From the electromagnet and electromagnetism came the electric telegraph in 1837, and forty years later, the telephone.

Great opposition had to be overcome in introducing the electric telegraph. The railroad itself did not have greater difficulty in making its first introduction to practical use. It was in connection with the railroads, however, that the electric telegraph first found employment in Europe, since the telegraphic announcement of the despatch and approach of trains was a recognized safeguard to the traveling public worthy of the initial expense on the aerial conductor. In the United States the telegraph was inaugurated in 1844 under Government appropriation by a bill which with difficulty passed through the Senate in the closing hours of its 1843 session.

Although the voltaic cell paved the way for the electric communication of intelligence, it was incapable of enabling electric transmission of power to be practically realized. The electric motor was indeed produced under its auspices and electric lamps were also produced with it, particularly the arc lamp. The cost of electric power from existing primary voltaic batteries is, however, mainly determined by the cost of metallic zinc, which, being obtained by metallurgical processes of reduction from zinc ores, is necessarily relatively expensive, and the cost of electric power from such batteries is upon any extended scale prohibitively great. The dynamo-electric machine, however, enabled electric power to be obtained at a cost not greatly in excess of the cost of producing mechanical power. It has been the development of the dynamo, the improvement in its efficiency and the reduction of its cost, which has led to the modern development of electric lighting and power transmission. The dynamo-electric machine is already so efficient in large sizes, that there is practically no room for very marked improvement in the future in this direction. We may always hope for improvement in cheapness, compactness, convenience and other good qualities of dynamo-electric machines, but in efficiency, the limitations to possibility have already been nearly reached. It is curious that unless all existing scientific knowledge is at fault, the possibilities that all futurity can offer in the direction of improving the efficiency of conversion from mechanical to electrical, or from electrical to mechanical power are limited to within the small compass of 4 or 5 per cent; whereas, with the existing heat engines employing fuel and which far antedate the dynamo-electric machine, the limits within which future improvements in efficiency can take place are from 70 to 95 per cent.

Accompanying the complete change in the attitude of public opinion toward electricity during the nineteenth century, attendant upon its gradual industrial utilization, has been a corresponding equally marked change in the attitude of electricity toward industry and daily life. The physicist and electrician of 1800 worked in an atmosphere as distinct from that of the work-a-day world as does the student of Sanskrit in regard to occupation, or the polar explorer in regard to location. At the present day, however, this isolation has completely disappeared, partly by reason of the fact that the general public has become slowly better educated in scientific matters, and has to this extent moved toward the physicist, partly because the applications of physics to industries are already so numerous, and partly because a large class of workers has of recent years been created and employed, generically classed as engineers and technologists, who occupy an intermediate position between the physicists on the one hand and the business men on the other, and whose duty it is to apply the laws of natural science to the purposes of the community. The result is that not only does almost every physical research have a direct bearing and value in technology, engineering and industrial affairs, but it is gradually becoming recognized that there is no better investment for public advantage than that in scientific or technological institutions, and that the specialized study of science is highly remunerative to the community at large.

The Twentieth Century.

The rate at which epoch-making discoveries are made mainly depends upon two conditions, namely, upon the aggregate amount of labor and investigation intelligently directed upon important problems, and upon the reserve of Nature's undiscovered forces, laws and capabilities. If, as during the early and middle ages of history, but little aggregate intelligent effort be directed to investigating the laws and resources of Nature, it is not likely that much return will be made in the discovery of new methods of controlling the forces surrounding us. Similarly, if it should be admitted that the resources of Nature available to humanity were already nearly exhausted, then it might be expected that but little further return in successful discovery could be obtained for even the greatest aggregate labor in search for new implements and processes. As for the effort, there never has been a period at which the total investigation and intelligent search for new means of harnessing and subjugating natural forces, was greater than at present, although much more total effort, and much better organization of the existing total effort could be, and doubtless will be, exerted. As for the latent richness of Nature's undiscovered wealth, while we have no knowledge of its amount, yet we have reason to suppose that it is yet practically unfathomed and untouched. Surely a mortal would be bold who should say that amid the forces on an enormous scale that surround us, the bounds to human utilization of them are already within sight. Only when the nature of gravitation, matter, energy and electricity in the earth and in the sun are clearly understood, will such a contention seem to be worthy of consideration. We may, therefore, reasonably expect that the rate of discovery, new means and methods of accomplishing human aspirations, will increase rather than decrease in the century to come.

The future progress of electricity and its applications in the twentieth century can only be estimated with reasonable accuracy on the unreasonable assumption that no new epoch-making discoveries will be made or that factors which are now at work in the development of the science and art will remain practically unchanged by new discoveries. As to what new discoveries will be made it is of course impossible to predict, and a single epoch-making discovery might revolutionize modern industry and crush every estimate of the most far-sighted observer. It is only possible to say what discoveries cannot be made without seemingly infringing the laws of nature as at present interpreted. Thus it is at present absolutely inconceivable that electrical energy for the production of light or power on a large scale could be obtained from any battery to which neither substance nor energy was supplied at intervals from without, because such a conception is contrary to the laws of the conservation of energy, which to doubt is to doubt the results of all accumulated human observations and experiences since the beginning of recorded time. On the other hand, to see by wire in the same manner that we now hear by wire with the aid of the telephone, is a perfectly reasonable conception, even though it may never be accomplished, and is not, perhaps, inherently more wonderful or improbable than the already accomplished hearing by wire might have seemed to intelligent persons at the beginning of the nineteenth century.

Moreover, the applications of electricity depend not only upon the progress of electricity and the electric arts, but also upon the contemporary sociological conditions, and unless the time is ripe for the reception of a certain improvement, the improvement itself is likely to lie sterile. Thus, at the present time, it is well known that it is practically feasible to communicate between railroad stations and moving railroad trains by electrostatic or electromagnetic induction, without any metallic contact between the moving train and the telegraph wires beside the track. But it is difficult to see how such a comparatively wonderful and certainly convenient capability can come into extended use, for the reason that the time which elapses between the stoppage of trains at successive railroad stations is not sufficiently great to make the services of a special operator on the train remunerative. If the same facility existed for communicating between stations on shore and ships at sea on long ocean voyages, it is highly probable that such a method of communication, if commercially practicable, would come into use.

Power Transmission and Distribution.

So far as concerns the long-distance transmission of electric power, the present tendency is certainly toward the production of higher electric pressures and the reduction of the cost of transmission. We may reasonably hope that the twentieth century will witness great achievements in the harnessing of such large water-powers as those at Niagara. Thus there are said to be about 7,000,000 of horse-power in the Niagara Falls, and with the exception of some tens of thousands of horse-power now utilized, or in course of utilization, the vast remainder is expended in the innocent but humanly utterly valueless result of warming the overflowing water about 1° Fahr. Although the falls are a very beautiful spectacle, their value to the country, and to the whole world, would be far greater if they were entirely removed and replaced by a dam and a vast area of wheel-pits for the local utilization and distant transmission of electric power. It is reasonable to expect that the distance to which such power could be economically transmitted will ultimately depend upon the cost of purchasing right-of-way and upon the length of line over which security from accidental break-down can be guaranteed, rather than on any purely electrical considerations of the cost of conductor. Only a few years ago a line pressure of 30 kilovolts was generally regarded as hopelessly impossible, while at the present time that voltage is coming to be regarded as only moderately high.

The electric distribution of power by stationary motors seems destined to make great advances not merely for use in mines and factories, but also for domestic service of every kind. In all large cities the tendency is to use muscular power less and motor power more.

Transportation.

In the use of electric power for transportation purposes it is reasonable to expect that not only will the suburban railroad transportation be conducted electrically, but also that high-speed passenger traffic between large cities may be conducted electrically. There seems to be no reason why passengers should not be carried on a specially constructed elevated structure, devoid of grade crossings, at any speed up to say 150 or 175 miles per hour, if electric motors are employed for the purpose and the rolling stock is designed accordingly. Although the cost of such an undertaking may seem almost prohibitive at the present time, yet the tendency is ever to increasing speeds in the face of the dictates of mere economy in transportation. Up to the present time electric transportation has been practically limited to dealing with the economic problem of making frequent starts and stoppages with the greatest convenience and least expense. It remains to show the capability of the electric motor to develop high speeds with the minimum weight and vibration where economy is of secondary rather than primary importance.

In the course of time, with improvements in automobiles of all kinds, it may be expected that horses will be banished from the streets of large cities and all urban transportation be carried on by mechanical means.

The progress of electric automobiles depends upon the development of electric-power storage. Under existing conditions, the leaden storage battery can only be successfully used for automobile propulsion within a relatively small running radius, and with the handicap of considerable weight, conditions which are likely to confine its principal use to city streets. If, however, the available energy per pound of storage cell could be largely increased, the convenience and simplicity of the electric automobile would give it immediate superiority over all existing mechanical prototypes. In view of the large amount of effort that has already been expended unsuccessfully in improving electric storage, a marked improvement in the apparatus would probably involve fresh discovery; but there seems to be no reason why such a discovery might not be made. It would indeed be remarkable if in the whole vast range of nature's combinative possibilities this particular possibility did not exist. A great practical improvement in electric storage would have a marked influence on many industries. It is even possible that large ocean steamers might be propelled by motors, deriving their power from stored electric energy. In order that this idea should be realized, however, the improvement in existing electric storage apparatus would have to be very great. There is certainly no immediate possibility, nor any future probability of introducing electric motive power to propel large vessels except with electric storage apparatus. In other words, it cannot reasonably be advantageous to replace the mechanical transmission of power through shafting from steam-engines to propeller by electric transmission, using the engines to drive a dynamo and a motor to drive the propeller.

Electric Lighting.

In electric lighting there is room for an enormous improvement in the efficiency of conversion from electric power into light. At present the incandescent lamp only converts about 5 per cent and the best arc lights about 10 per cent of the power they receive into radiant energy which affects the eye as light; or, in other words, these instruments waste respectively about 95 per cent and 90 per cent, mainly in radiant energy that the eye does not perceive. It is conceivable that nearly all this waste might be avoided or that nearly all the energy delivered electrically to the electric lamp might be converted into light, even though this result may never be accomplished.

Electro-Chemistry.

In the direction of electro-chemistry we may expect great advances. This is at present a youthful electrical industry, and yet it has developed so rapidly as to absorb the production of the elements aluminum, hydrogen, magnesium, potassium, sodium and silicon, as well as the compounds carbide of calcium and carborundum. Moreover, by electro-chemical methods large quantities of caustic potash, caustic soda, potassium chlorate and calcium chloride are produced, not to mention the refining of metals and the extraction of metals from their ores. We may expect the production of the electric furnace and the electrolytic vat to increase in quantity and in importance from year to year.

The possibilities of synthetic chemistry, including electro-chemistry, are so wide, without transgressing the limitations seemingly set by natural law, that any great discovery in this direction might appreciably alter the established order of productive agencies. There are already a few substances, such as madder, at one time fairly extensively cultivated, the cultivation of which has been practically arrested by the development of cheaper manufactured equivalents of synthetic chemistry. It is reasonable to expect that the growth of chemical sciences and arts will still further invade the territory of agriculture. Even now it is possible to manufacture alcohol by a series of processes involving electro-chemistry and starting with calcium carbide, although it does not seem that the synthetically manufactured product of the laboratory has yet competed with the product of the sun's chemistry in the open fields. It is conceivable that food products could be manufactured artificially cheaper than they are produced in the field or in the sheep and cow, with the aid of sunshine; but such a step might be feasible long before it would be commercially possible.

As to whether we may hope to obtain the energy of coal by electrical means without the intervention of the steam engine, it is impossible to conjecture. It is not at all probable that the energy could be obtained electrically from a non-conducting substance like coal, and the problem therefore narrows to the extraction of the chemical energy of coke. The solution of this problem would practically involve electro-chemical discovery, and appears to lie beyond immediate existing means. Even if it could be accomplished on a large scale, however, the process might be unremunerative or economically impossible. It is certainly reasonable to expect that improvements will be effected in the yield of energy obtained from coal, but whether that improvement will be effected by chemical, electrical or thermodynamical means, remains to be ascertained.

Telegraphy and Telephony.

In telegraphy we can hardly look for much improvement in the ordinary Morse system as operated by hand. That system would seem to have been already reduced to its simplest elements. It is in the direction of automatic telegraphy that we must look for future improvements in land telegraphy. It would seem reasonable to expect that with the aid of mechanical transmitters and receivers long circuits between large cities could be worked remuneratively at very high speeds and correspondingly reduced rates in such a manner as to enable the traffic on those circuits to replace the postal service, within certain limits.

In submarine telegraphy it would seem almost impossible greatly to increase the speed of manual transmission over the long cables already laid; or, in other words, a large increase in the speed of manual transmission over existing cables would involve some new discovery. There is room, however, for improvement in the methods of automatic submarine telegraphy, whereby the limits of speed in transmission may approach more nearly those seemingly set by fundamental physical laws. Means may be found for constructing new long submarine cables in such a manner as to enable much higher speeds to be obtained from them.

In the direction of wireless telegraphy it is reasonable to expect that the distances to which wireless messages can be transmitted may be greatly increased, and means developed for preventing the interference of separate messages. While it is not likely that wireless telegraphy will take the place of wire telegraphy on land, to any considerable extent, yet on the ocean, as a means of communication between ships, or between ship and shore, the system should find much utility. It may be hoped that in time all important light-houses may also become Hertz-ray houses for the transmission of invisible beams to vessels in the neighborhood, through fog, and beyond the bend of the horizon due to the rotundity of the earth. It is conceivable that such a system, sufficiently improved, would enable communication to be maintained with distant vessels for hundreds of miles from shore.

In telephony we may fairly expect a very great extension of the system in all large cities. Moreover, the distances to which telephony will be commercially extended will probably be considerably increased. Large business offices will be supplied through several telephone lines and the business of the officers will in a large measure be conducted by telephonic conversation with distant points. The ramification of the telephonic system to houses of all kinds should continue until the difficulty of obtaining telephonic communication with any particular subscriber offsets the advantage of an increasing number of subscribers. In other words, the more perfect the telephonic system in its details of operation and facility for affording communication, the greater the number of subscribers who can be induced to take part. There is no reason why eventually nearly every building for business or residence, except the smallest, should not possess telephonic communication.

It is also reasonable to expect that not only the number, but also the magnitude, of electrical undertakings, will increase in the century to come. The magnitude of industrial and engineering enterprises is at once a measure of the civilization and of the education of the period to which they belong, since not only are mutual confidence and co-operation required in corresponding measure, but also a corresponding acquaintance, by experience and knowledge, with those laws of nature under which the enterprise is conducted. So long, therefore, as civilization advances there can only be expected a continued increase in the magnitude and scale of enterprises of every kind, including those utilizing electricity. In view of the active part which electricity seems destined to play in the future, the twentieth century must be expected to offer greater interest and development in electricity and in electrical applications than the century which has just closed. There never has been a time in the past when the electric science was so closely associated with the electric arts as now, and the connection between the two seems likely to become more intimate and more beneficial as the car of time rolls on.

A CENTURY OF PROGRESS IN STEAM ENGINEERING.

BY A. F. NAGLE, M. E.

How did the beginning of the nineteenth century find the steam engine, what have a hundred years done for it, and what remains for future generations to accomplish? The object of this article is to discuss these questions in such manner as to enable a busy engineer to obtain a general grasp of the development of the steam plant during the century, leaving him free to search in historical books for more detailed information.

At the beginning of the nineteenth century the steam engine was working under 10 to 15 lbs. steam pressure and making from 10 to 30 revolutions per minute; it expanded steam from three to four times and was aided by both jet and surface condensers. It required the consumption of from 9 to 10 lbs. of coal an hour to develop one horse-power. To-day we can use steam of any desired pressure; reciprocating engines are running at from 100 to 300 r.p.m., making from 600 to 900 ft. piston speed a minute; they can be made to expand steam to any extent desired, which may be 40 times, and the economy has been brought to almost one horse-power per pound of coal per hour. It is not presumptuous to say that very little more remains to be done.

In its mechanical parts and functional elements the steam engine was complete at the beginning of the last century, but as a machine for converting the latent or potential power of coal into useful work it was not only a crude apparatus but the laws under which it worked were unknown. While the heat from burning coal was used to make steam, no scientific knowledge existed as to the measurement of this heat. In a general way it was known that it required about six times as much heat to evaporate water into steam as to bring it to the boiling point, yet no exact data existed on this point. The term "British thermal unit" (B. T. U.) had not been thought of.

Practice preceded science, and the engineer was left for many years to grope along as best he could, designing engines mechanically better and better, but with no scientific knowledge to guide him in a definite line of improvement. Watt had observed the rapidity with which steam condensed in the presence of a colder substance; his first experiments showed that three times as much steam was condensed on entering a cylinder as was required to fill it, so he very logically provided a separate vessel for a condenser. The rapid escape of heat by radiation and condensation was recognized as a fact to be avoided, but no scientific knowledge existed of the laws that governed it.

The nineteenth century has disclosed complete and perfect analyses of the laws which govern steam-engine design and construction, and it only remains for the engineer to apply these laws to meet his special requirements. Moreover, the steam engine has profited by the general advance in mechanical skill during the century. How much it itself has contributed to this improvement it would be difficult to determine. Metallurgy, forges and foundries could never have attained the magnitude and economic production they have but for the power that steam gave to them. At the beginning of the century the designing engineer was handicapped by the crude state of the mechanic arts in the construction of his conception. To-day he can have anything he is able to pay for; materials of the finest quality and workmanship of the most refined character are at his service. In a general way, the advance has been from unreliable cast iron to a definitely-known quality of steel. Then, nothing was known of the chemical or physical properties of metals; to-day, foundries, forges and steel works are all guided by scientific experts in their productions. In short, from guesses, steam engineering has passed to mathematical certainties during the nineteenth century.

While the engineer and mechanic have been busy in the workshops, the scientist has likewise been busy in the laboratory. During no century of the world's history has the human mind delved so deeply into nature's secrets as in the one just closed. Probably the first suggestion that there was some definite relation between work and heat was made just prior to the birth of the century, by Count Rumford, who, in 1798, discovered that the heating of the metal of cannon by the boring tool had some definite relation to the power exerted by the lathe. In a crude way he determined that about 630-foot-pounds of work were expended for every pound of water heated one degree. Until the thirties of the nineteenth century nothing further was done in this field, when Joule determined the mechanical equivalent of heat to be 772 foot-pounds. (Prof. Rowland, of Baltimore, subsequently found the value of 778 to be more exact.) As chemistry had demonstrated the indestructibility of matter, so physicists began to find that nature's forces were also indestructible; although a manifestation of force in one form might disappear, it reappeared in the form of heat, and vice versa. This law of the conservation of energy gave a sound basis for the study of the various laws of heat as applied to the steam engine, and there came to be established a standard of economy which theory describes as perfect; the nearness of practical results to this standard, called thermal efficiency, was an indication of what was accomplished and served as a guide to future improvements.

Steam Generating Plant.

Before proceeding to the discussion of the engine itself, it will be proper to divide the subject into its two main processes, namely, the generation of the steam in the boiler, and its use in the engine. So far as the writer is aware, no records exist of the separate performance of the boilers and engines of early periods. Mine-pumping engines gave the best opportunity for ascertaining the useful work done by engines, and the coal consumed gave a rough measure of economy. From this came the term "duty" of an engine, which means the number of foot-pounds of work done per 100 lbs. of coal burned. This is a comprehensive term in that it eliminates all intermediate processes and losses and expresses broadly the amount of work obtainable for a given expenditure of money. The earlier attempts at pumping by steam gave a "duty" of about 3,000,000 or 4,000,000 foot-pounds. Before Watt improved the engine a duty of about 6,000,000 or 7,000,000 had been obtained. Watt brought this to nearly 20,000,000. To-day we obtain 150,000,000!

There is no reason to doubt, judging from the construction employed in the early part of the century, that the boiler was not so inferior an apparatus as the engine, in comparison with present practice. A big tea kettle is not a very bad steam boiler, and that is what the early steam boilers were. It is safe to say that the best steam-generating apparatus of to-day, including a good furnace, water or fire-tube boilers, and economizers, will not show a reduction in coal consumption, for an equal quantity of steam generated, of one-half over what was accomplished in 1800. If we apply the term boiler efficiency to the ratio between the heat converted into steam and the potential heat contained in the coal, I should say that this efficiency might have been from 40 to 45 per cent a hundred years ago. To-day we obtain at the best from 80 to 90 per cent, but a general good result is from 60 to 70 per cent.

Let me call attention to the several elements that go to make up this improved economy. First, we have a little better furnace; second, the boilers themselves are of better design for the utilization of heat; third, economizers placed in the path of the escaping gases are new and have added something to the plant efficiency; fourth, superheaters are attached to boilers, but contribute more to the economy of steam in its passage through the engine than to direct boiler economy. While these are elements which go to improve fuel economy, far greater progress has been made in boiler design and materials to secure greater safety and durability. From 10 to 15 lbs. pressure in 1800, boilers are now made to stand any pressure the engineer may choose to carry. No single standard form has been developed during the century, but a great number of designs are still competing for supremacy. It can, however, be safely said that for special purposes, peculiar types are practically of established forms. But each form, or type, is an excellent apparatus, and presents no probable prospect of any material improvement.

Considering for the moment the efficiency of a modern first-class boiler plant in terms of water evaporated from and at 212° per pound of combustible, 13 lbs. have been obtained where no economizer was used; with an economizer this would probably have been increased to 13½ lbs. As the heat in 1 lb. of combustible is only sufficient to evaporate 15 lbs. of water, the thermal efficiency would have been $\frac{13.5}{15} =$ 90 per cent. Can we look for any material improvement over this splendid accomplishment? So far as converting the potential heat in the coal into actual heat of steam, we have obviously reached very near to perfection.

Utilization of Steam.

What do we accomplish in converting this steam into useful power? The best record to date is nearly 23 per cent, which was accomplished by the Nordberg pumping engine. This corresponds to nearly one indicated horse-power per pound of coal per hour. The more general good practice, however, is from 2 to 3 lbs. of coal per hour per indicated horse-power. Still, this is an enormous advance over the best practice of 1800, which was about 9 lbs. per hour per indicated horse-power. It is a curious fact that this tremendous gain in economy is not due to the discovery of a single new principle in nature in addition to what was known in 1800; the discovery of scientific laws has merely enabled builders to make more intelligent application of forces already familiar. At the beginning of the century, as previously stated, boiler construction was so inferior that only about 10 lbs. gauge pressure could be safely carried; and although the compound engines of Hornblower and Woolf were known, yet in the imperfect state of the mechanic arts no better result was obtained with them than with the single-expansion cylinder cutting off at about one-third stroke.

TABLE I.

Theoretical steam per I.H.P.-hour with no clearance, no leakage and no condensation; based on 2 lbs. back pressure absolute.

Expansions.	25 lbs. abs.	100 lbs. abs.	200 lbs. abs.	300 lbs. abs.
3	20. lb.	....	....	....
4	19.5 lb.	....	....	....
6	14.8 lb.	11.8 lb.	....	....
8	14.1 lb.	10.8 lb.	....	....
10	13.7 lb.	10.2 lb.	9.50 lb.	....
15	....	9.26 lb.	8.52 lb.	....
20	....	8.78 lb.	8.00 lb.	7.70 lb.
25	....	8.46 lb.	7.65 lb.	....
30	....	....	7.37 lb.	7.08 lb.
35	....	....	7.20 lb.	....
40	....	....	7.07 lb.	6.74 lb.

By means of formulas accessible to anyone who chooses to study the subject, it is easy to compute what high steam pressures and large expansion make possible. Ignoring clearance and loss by radiation and condensation, and assuming the vacuum to be within 2 lbs. of perfect, Table I will serve to show what relations exist between steam pressures and the number of expansions. It will be observed from this table that if Watt had but 10 lbs. steam pressure in his boilers, and expanded that steam three times, there was a theoretical consumption of steam of 20 lbs.; while to-day, with 185 lbs. boiler pressure, expanding 20 times, there would be required but 8 lbs. We can therefore make the comparisons given in Table II.

TABLE II.

Year.	Steam pressure in boiler.	Number of expansions.	Coal per hour per I.H.P.	Water evaporated per lb. of coal.	Pounds of steam per hr. per I.H.P.	Theoretical of last column.	Ratio of last two columns.
1800	10 lbs.	3	9.	5.5 lbs.	48.5	20	41%
1900	185 lbs.	20	1.4	12.0 lbs.	12.0	8	67%

As the steam jacket was used by Watt, aside from the increased steam pressure and greater number of expansions now practiced, we have effected a saving in having less clearance space, less leakage, due to better workmanship, and less radiation, due to better exterior coverings. These items go to make up the ratios in the final column of Table II, showing that in 1800 only 41 per cent of the theoretical possible was realized, while to-day we realize 67 per cent. It is possible to reach closer to perfection than we have done, but the general conditions of life are such that only in special circumstances can we afford to pay for a plant giving extreme economic results, and hence while 1 lb. of coal per hour per indicated horse-power is attained in a few cases, the average consumption remains nearer to 2 lbs. and more. The loss from condensation is still quite great, but is being reduced to some extent by the use of superheated steam. There is a possible saving of 15 to 20 per cent by superheated steam over saturated steam; and a more general application of superheat is the most probable line of improved economy open.

Mechanical Details.

It is impractical and would be unprofitable to go over the numerous minor constructions which have come and gone during the century, but a few which have remained may be mentioned, as well as such as are new and likely to remain as long as the steam engine is the principal prime mover. The gravity or pendulum ball governor that Watt applied to his engines is still used by many engine builders, and when used in connection with a liberating valve gear is a very good governor. The Porter governor and shaft governors are new, and are necessitated by valves and valve gears offering considerable resistance. High-speed spring governors were born during the century, and are likely to remain in use for certain types of engines. Shaft governors are of modern design and have attained a high degree of efficiency, with great power.

The D slide valve, which is said to have been made in the shops of Boulton & Watt at the beginning of the century, is still in service, but has been shorn of much of its chief drawback by being balanced by back-pressure plates. The rocking valve erroneously bearing the name of Corliss is a product of the century, and retains its successful position notwithstanding the onslaught made upon it from time to time by inventors of substitutes. Probably the greatest improvement in valves during the century has been the piston valve, and it will doubtless continue in use.

Valve gears are legion in number, but the variable cut-off controlled by the governor is the striking improvement of the century. The poppet valve used by Watt continues to be used on large vertical engines, and more particularly on steamboats. Lifted by a cam operated by an eccentric, it was necessarily a late cut-off mechanism, but a striking improvement was made in 1841 by Fred. Sickels, who cut in two the valve rod so that the valve could be freed from the lifting cam and allowed to drop to its seat at any period of its upward (and later, the downward) stroke. Variable cut-off was also obtained by the link-motion of George Stephenson in 1829 on his famous locomotive, the "Rocket."

The cutting off of steam was first effected by a sliding plate on the back of the main slide valve, thus closing the port in its opening motion. The point at which this cut-off occurred was for many years adjusted by hand and has always been so adjusted on marine engines, but in 1826 James Whitelaw, of England, is said to have controlled the point of cutting off by the governor. In this country this form of cut-off was used for many years until the Corliss type superseded it. In 1851 Corliss made a round-seated valve in place of a flat-seated one. The rocking motion of this valve was favorable to the application of the beautiful type of valve gear known as the wrist-plate motion, invented by Corliss. Then he took the Sickels liberating valve-stem feature and the governor-regulating feature already known, and made the handsome engine known by his name.

The pioneer in the construction of the high-speed engine was Chas. T. Porter, who brought out the Porter-Allen engine in 1861. It was a four-valve engine, the valves being balanced by moving between two parallel surfaces; the exhaust valves were moved by a fixed eccentric, and the steam valves through a half-link whose block was shifted by the governor.

Rotary Engines.

About the middle of the past century innumerable inventions were made in so-called rotary engines, but they are nearly all obsolete now. Most of these inventions have their origin in a mistaken notion that there is a loss of power in a crank engine; and others attempt to economize in space, gain in rotative speed, and still maintain as good steam economy as is obtained in a crank engine. The utter failure in the latter feature is rarely offset by the success of the first two. In their analysis, all these rotary engines are really crank engines with the pistons attached directly to the crank, but substituting sliding blocks in the cylinder for connecting rods outside of it. The true rotary engine of the century, and one not yet fully perfected, is the steam turbine, which has been so greatly developed by Mr. Parsons. The principle of action is that of an impact water wheel. It is worth while to put on record the latest official test of this engine, and this is accordingly given in Table III. Here is truly a new development of a very old principle. The performance of the engine is now equal to the best reciprocating types, with greater possible improvements before it. If the same degree of success shall be obtained in the steam turbine as has already been realized in the water turbine—and there is no good reason known so far which would prevent this—an efficiency of 90 per cent would be obtainable. This would mean that the steam consumption would be reduced to approximately 7½ or 8 lbs. per horse-power-hour. It is not unreasonable to predict that for electrical uses this type of engine may become a standard form in the near future.

TABLE III.

Parsons Steam Turbine. Direct-Connected to Polyphase Alternator. Speed 1500 r.p.m. Steam pressure 162 lbs. Superheat, 26° Fah.

Kw.	I.H.P.	Steam per Kw.-hour.	Steam per I.H.P.-hour.
1190 (over-load)	1860	19.3 lbs.	12.35 lbs.
995 (full load).	1550	20.1 lbs.	12.86 lbs.
745 (¾ load)...	1195	22.2 lbs.	14.21 lbs.
500 (½ load)...	781	25.4 lbs.	16.26 lbs.
246 (¼ load)...	384	33.8 lbs.	21.63 lbs.

Friction, field not excited, about 6 per cent of full power. Speed regulation between full and no load 3.6 per cent.

Surveying broadly the century's progress of the steam engine, it has been due more to the development of the mechanical arts, for which the century has been noted in so many other fields of human effort, rather than to any great invention or discovery in science. As to its future, it can safely be said that no scientific discovery will be made which will change its status as a prime mover, nor will any great invention affect its position, but we shall continue to apply the skillful work known to the art to a more general practice, and thus bring the average nearer to the highest. An eminent engine builder once said to me: "Mechanical engineering is not what it should be, but what people are willing to pay for." And if I may predict for the coming century, it will be one whose people will be willing to pay for better engines and will, consequently, be provided with them.

The Independent Telephone Exchange at Atlanta, Ga.

BY E. E. CLEMENT.

Many of the independent telephone companies are turning to the multiple switchboard, following the example of the Bell companies. The arguments advanced for and against the multiple switchboard, and the defects of the old-style transfer or divided central boards, are fairly familiar to all telephone men. It is not intended in this article to take up the broad question of multiple vs. trunking, but merely to set forth the main features of a large modern telephone exchange in which the trunking principle has been successfully used throughout, and which is probably as good an example as can be found of its kind.

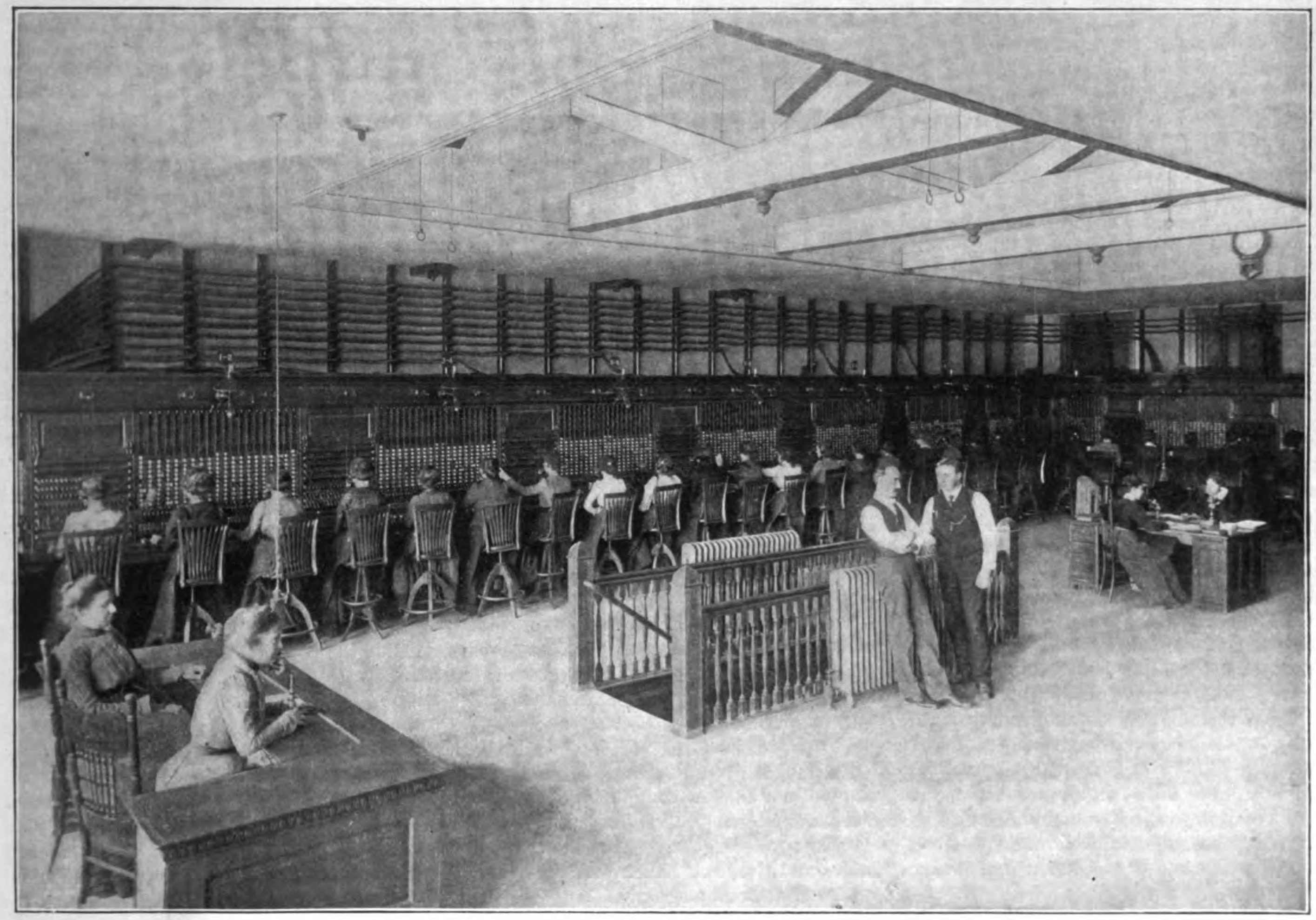


FIG. 1.—THE OPERATING ROOM OF THE ATLANTA INDEPENDENT TELEPHONE EXCHANGE.

The Atlanta company, after much preliminary work and calculation, decided to install a 2000-line board, with an ultimate capacity of 4000 lines, in its main building. As the work progressed, however, it was found that several boards would be required in other parts of the city, and the plans were slightly changed so that now the main exchange is equipped for 3000 subscribers, with additional facilities in case they are needed, bringing its capacity up to the original figure of 4000. The construction work and the installation of the exchange were carried out by the Atlanta Standard Construction Company, while the manufacture, erection and installation of the apparatus were under the personal supervision of Clement & Gharky, Philadelphia, under whose patents it was manufactured. (All of these patents are now the property of the Sun Electric Manufacturing Company, of Philadelphia.)

The Atlanta system is essentially an underground system. There is one long overhead line starting in the suburbs and passing about the city and out for about twelve miles, and an extension like perhaps half as long giving access to certain groups of subscribers who could not be economically reached otherwise, but most of the subscribers during the past year have been served through the cables. All of the main cables are 120-pair, lead-sheathed and paper-insulated cables of standard type, made to rigid specifications and drawn into the ducts by the John A. Roebling's Sons Company, of Trenton. The conduits are of terra cotta, in four-duct and six-duct units; the main trunk conduits have sufficient capacity for over 4000 lines. The distributing poles are of locust, averaging 50 ft. in height, and provided with square platforms strongly framed with iron, and wooden terminal boxes containing double rows of terminal strips with protective devices. Wherever practicable within the city, conduits were run and the cables taken directly into the basements of buildings to be served, distribution being then effected by means of small terminal boards and interior cables.

At the exchange building all cables enter through the front foundation walls, passing into a cable vault beneath the entrance door and extending back some 25 ft. From this vault a vertical brick shaft passes up to the second floor, into a large room over the main entrance, where the distributing and cross-connecting boards are located. This cable shaft is located about 20 ft. back from the front wall, and between it and the latter is a second vertical shaft which carries the switchboard line cables up to the third floor, where they pass directly onto the wall brackets or hangers shown in Fig. 1 over the top of the switchboard. The arrangement of rooms in the main building is as follows: On the first floor are the general offices, with a private office opening therefrom; a large back room, storeroom and instrument room. On the second floor, the whole depth of the building on the right-hand side is taken up by the operators' sitting room, dining room and retiring room; the front room on the left-hand side contains the distributing and cross-connecting board and power plant. The entire third floor is occupied by the operating room; the operating room is entered by a central stairway; the switchboard extends down two sides of the room and across the rear end, and all the rear windows are hermetically closed.

Fig. 2 shows the power room, with its switchboard, and one side of the combined cross-connecting and distributing board. The cables enter at the right-hand side from beneath and pass under a false floor, being brought up in rows along the sides of the distributing-board frame. The latter is an iron structure formed of angles and tees forming a cage with cross-bars overhead of iron pipe carrying vertical pins 5 ins. in height arranged in rows; each pin has a sleeve of hard fiber slipped over it to prevent short-circuits or crosses in case the insulation on the jumper wires should break. The cage has two partitions inside, and each of these is faced with hard-wood panels, as are also the two sides and the back. Each cable is brought up to the foot of the panel and there fitted with a pot head, the wires from which are formed up and led to rows of pairs of brass terminals passing through the panel. On the outside of each panel is a corresponding row of fuse protectors on porcelain bases, to which the cable wires are connected.

From each fuse block a continuing pair of wires is threaded back through the panel and up the inside face to the top of the frame, where it is led along between the parallel rows of pins to its appropriate terminals on the rear face of the board. This whole rear face is covered with small brass terminal connectors having binding screws to facilitate the changing of jumpers, the latter being threaded through in each case and being connected on the face of the panel. The switchboard line cables are 52-pair interior cables, and start from the inside of the rear face of the cross-connecting board, thence passing down under the false floor and across to the right-hand side in the picture, where the front of the switchboard cable chute is just visible near the ladder shown. Each cable has its terminal wires formed up and threaded through one side of the panels to the connectors.

It will be seen from this description that distribution and cross-connection is accomplished in the simplest possible manner and without the slightest confusion. Instead of a tangled mass of jumper wire there is a symmetrical set of leads on the top of the iron frame, accessible either from beneath or from above, and separated by the rows of pins into regular intersecting avenues, rendering it very easy to trace any particular connection and change or remove the same if desired. Walking inside the cage, one finds three little chambers with good head room and plenty of elbow room; all cable and wire connections being on the inside of the panel in orderly fashion, and everything perfectly accessible.

To one walking around the outside of the cage the sides or faces present only an array of terminal protective devices and brass connectors, each bearing the number of its line or switchboard wire as the case may be. By removing the protective devices, which are held in spring clips and are very compact (having fuses of the Maxstadt type), the terminals are left open for testing both ways, and an instantaneous connection can be effected by means of a small wooden handle with two pairs of terminals, connected by a four-conduct-

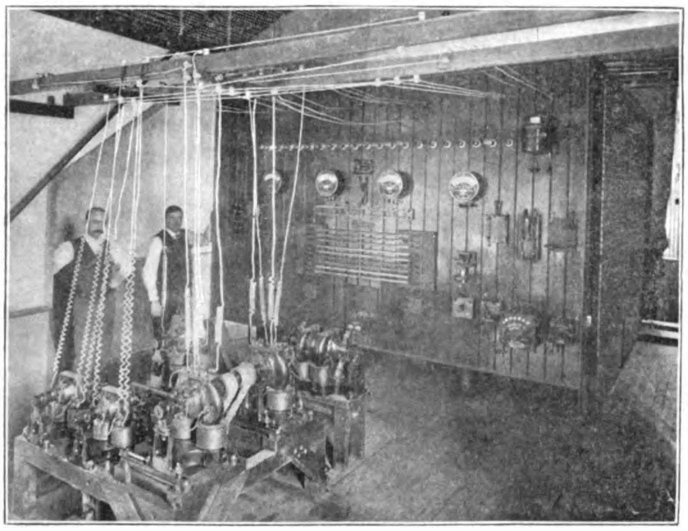


FIG. 2.– THE POWER ROOM.

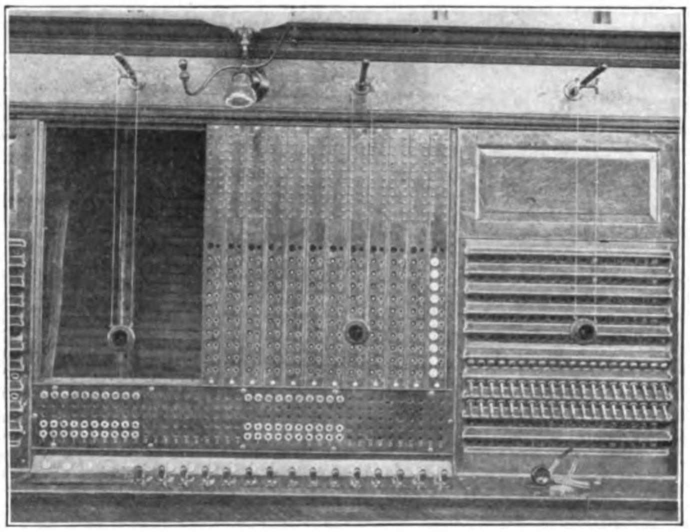


FIG. 3.—ONE SET OF PANELS.

or flexible cord to a permanent test table at one side of the room. This is not shown in the illustration, as it is behind the board on the left.

Across the front of the distributing cage, which would otherwise be open, and with about 4 ft. intervening, is the power switchboard, carrying voltmeters and ammeters, underload and overload circuit breakers for the charging machines, and all the main and local switches, starting rheostats, test ringer, wattmeter, etc. This board also has an iron frame, of pipes, angles and tees, and, like the distributing and cross-connecting cage, is strongly braced in every direction. In the photograph it is shown with temporary wooden panels, the picture having been taken when the exchange was first put into operation and before the slate panels had been received.

The power plant shown in the foreground of Fig. 2 was put in in the face of serious difficulty, to meet existing conditions. The only available source of electrical supply at the time was a 500-volt direct-current circuit. A 5-h.p. 500-volt Crocker-Wheeler motor was installed, belted to a countershaft hung on the under side of a heavy wooden platform which carried all the machines. From this the two charging machines are driven, either being capable of running independently, of course. A second or reserve motor was afterward added, and the entire arrangement proved to be fairly satisfactory pending the completion of 110-volt lighting mains by the local electric light company. In addition to this set of machines a water motor was provided in the basement with a ringing generator connected to it and wired to the power switchboard, to serve in case of failure of the 500-volt current, the storage cells having sufficient capacity to tide over any ordinary interruption. These batteries are Chloride accumulators of 500 ampere-hours capacity, and they are arranged in tiers on shelves, protected by an enclosing casing with glass doors.

There are duplicate sets of cells, one set being charged while the other is discharged, changes in connection for charging and discharging being made by means of the gang switches shown in the middle of the switchboard. This arrangement was made very simple to avoid blunders, one set of switches being always up and the other down. Twenty-six cells are employed in each set, the voltage of the signaling current on the lines being about 32, sixteen cells being therefore required for this service, and the balance furnishing current for the operators' transmitters, certain local switchboard circuits to be referred to and the lamp signals.

Passing now to the main operating room, which is shown in Fig. 1, it will be noted that the cables from the distributing board, coming up at the left of the picture, are taken from the top of the chute on to cable hangers or brackets supported on vertical hardwood studs secured along the walls, 25 ins. apart. The switchboard is divided into sections of three "positions" each, and there are three struts to each section, a pair of cables being let off from every third strut, beginning with the lowermost pair, and across the top of the board to the connecting terminals. The chute through which the cables pass up to the operating room is provided with doors on each floor, so that it can be opened for its entire length; and the same arrangement is followed with the chute through which the line cables pass up from the vault in the basement to the distributing board, perfect accessibility of every part of the line, either individually or in all its cable, being thus secured.

The arrangement of this switchboard is in many respects novel, and after over a year of continuous service it has proved itself to be eminently satisfactory. The board is divided, as just stated, into sections of three "positions" each. Two of these "positions" are taken by "A" operators, who answer all calls and initiate trunk connections; the third position being taken by a "B" operator, whose sole duty is to complete trunk connections according to instructions received from the "A" operators. This "B" operator does not ring, nor talk to any subscriber except when the line wanted is busy. Her sole work is to insert plugs, and the "A" operator does the rest. When the work is very light, all but the "B" operators can be dismissed, in which case these operators take up the work on the adjoining "A" panels; in order that they may do this, switches are provided on the right and left of each "B" panel, as shown, to connect the head circuits together.

Fig. 3 shows a section of three "positions" in course of erection, with parts removed to exhibit the inside construction. The most striking feature of the board to one not familiar with these systems is the enclosed gallery of ample dimensions which passes all around it, and is perfectly clear of cables or other obstructions. In Fig. 3, behind the left-hand transmitter, will be seen a continuation of one of the struts, referred to in connection with Fig. 1, bored to receive the horizontal members of a trunk cable frame. The trunk cables run along the wainscoting of the wall, where they are not only out of the way but absolutely open and accessible all the time, being arranged in an orderly fashion like the line cables of Fig. 1. They cross the floor of the gallery under short sections of false flooring raised 3 ins., these being loose so that they can be lifted when necessary.

At every third strut along the wall a pair of line cables is led off and taken across the top of the board to the front behind the moulding, where they pass down through the roof, the braided covering is removed and the wires are formed and laced to come down to the inside ends of the terminals on the top of the vertical strip. The eleventh pair of terminals on each strip and the eleventh opening in each case shown unfitted with a line unit, are "extras." These openings are normally plugged. In each section of the switchboard there are twenty vertical line strips, carrying normally two hundred line units. The first and tenth, and the eleventh and twentieth strips, however, each carry an extra unit the same as a line unit, wired to the chief operator's desk for one and the trouble operator for the other. The "A" operators call the chief the same as they would a subscriber, her desk being fitted with a row of annunciators consisting of plungers which also serve as keys, and which, when depressed, put her telephone set into circuit.

Each line unit is carried on a yoke secured to the back of the strip, the relay being of tubular form, and the lamp fitted in the front end of the tube. This is closed on the outside by a bull's-eye of translucent material, shown in the right-hand strip in Fig. 3, the bull's-eyes being removed from the other strips in that engraving, leaving the lamps exposed. Below the line strips the trunk panel is fitted with jacks and order keys. The panel is shown in Fig. 3 bored for the full equipment for 4000 lines, but with jacks for only 1000 installed. These are plain open-circuit jacks, each connected to its individual trunk line leading to some particular "B" section. In actual service it was found that two trunks from each "A" to each "B" operator was sufficient, giving four on each double "A" panel that lead to the same operator. The order keys at the top correspond, of course, with the pairs of trunks, the order circuits being separate from the trunks. The trunk and order-circuit cabling is wired on the trunk panel before it leaves the factory, and the connections are at one end, where the cable passes down the leg of the board and thence under the floor to the rack in the rear of the gallery.

Directly below the trunk panel and extending across each double "A" section is a signal panel, and directly in front of this are the "operators' strips," being a series of units composing the horizontal table. Each of these strips is of five-ply wood veneered on its surface with black fiber and carrying a pair of plugs and a combination key. The calling plug of each pair has a switch in its seat which, as long as it is not in use, connects the operator's head 'phone to the corresponding cord. No listening key is required, therefore, for as soon as the operator has inserted the answering plug in response to a call she is already on the line.

The combination key has two functions; in one position it connects the generator to ring, and in the other position it connects the corresponding signal lamp back of the plug to act as a supervisory signal, leaving it connected until the called subscriber answers, when it is automatically thrown off. This key, the plugs, and the plug seat switch are all wired in grooves in the edges of the strip before it leaves the factory.

The "B" section on the right of Fig. 3 consists essentially of a cast-iron panel in two parts, made in "stair-steps," and drilled through with rows of holes for the plug seats and "B" signals. The former are plain plug seats, tubular in form, held in place by a shoulder on one side of the iron and a nut on the other. The latter are plungers which serve both as push buttons and as signals. The row of these in front of any "B" operator represents all the "A" operators in the exchange, and when one pops out it means that the corresponding operator has come in on a trunk leading to one of the two plugs below it. This signal is only intended to guide the eye, for it is operated by the "A" operator having pressed her order-key on the trunk panel for this particular "B" operator, and as soon as she has done that she has crossed her talking circuit with that of the "B" operator and gives the order orally for the connection; but the visual signal is found to be useful in many ways.

If several trunk signals came in at the same time, the orders would be confusing to the "B" operator receiving them, but by a simple arrangement of the circuit these signals are made non-interfering; a "lock-out" mechanism prevents more than one signal coming in at a time, so that no confusion can result. At the same time, if the "B" operator happens to be busy or inattentive and misses an order, the signal shows her which operator called, and she can ask for the order to be repeated by simply depressing the plunger to its fullest extent, as this crosses her talking circuit with that of the corresponding "A" operator.

The wiring on the rear of the "B" sections, as well as the management of the cords and weights of the trunk plugs, is simplified by inverting the plugs; this also gives an opportunity to use long cords, which permit the trunk plugs to be used over a large part of either of the two adjoining "A" sections, as indicated in Fig. 4.

There are some novel features about the operators' suspension sets. In the first place the transmitters are suspended by bare conductors, which pass over insulated sheaves. This allowed the size of these conductors to be reduced so that they are almost imperceptible, and do not obscure or confuse the view of the board. The sheaves are carried on a sliding support, which is locked in position by the weight of the transmitter, the operator being thus able to adjust her transmitter up or down, inward or outward, by merely raising it in her hand. An automatic switch is provided, operated by a stop clamped on the cord so that when the transmitter is pushed all the way up by a retiring operator the battery is cut off. The head 'phone is plugged in on a jack underneath the table in the ordinary way.

Having described a few of the main features of the board, its operation will probably be now understood. Although no reference has been made to it, the reader has probably inferred that the board works with a central battery. This is true only as to signalling, however. Local batteries are used at the subscribers' stations. The subscriber calls by removing his receiver from the hook. This act closes the battery circuit and current flows through one coil of his relay, which closes the lamp circuit. The "A" operator, receiving the signal, inserts the answering plug of a pair, and being already on the end, is enabled at once to ask "number." If the number wanted is on her own section she inserts the calling plug in the jack of the line wanted and pushes the knob of her key in one direction at one operation. This connects the lamp signal corresponding to that pair of plugs, and a reverse motion of the key rings up the subscriber. The previous insertion of the answering plug connected the line relay in a bridge circuit, presenting high impedance to talking current but permitting the battery current to pass neutrally and retire the signal.

The supervisory signal, however, remains lighted until the called subscriber answers, and it is therefore unnecessary for the operator to "listen in." As a matter of fact, she has no means of listening in after the connection is made. When the called subscriber answers, the supervisory signal disappears, and a clear through circuit is established between the subscribers, with no branches or coils, and only one pair of cord contacts, interposed.

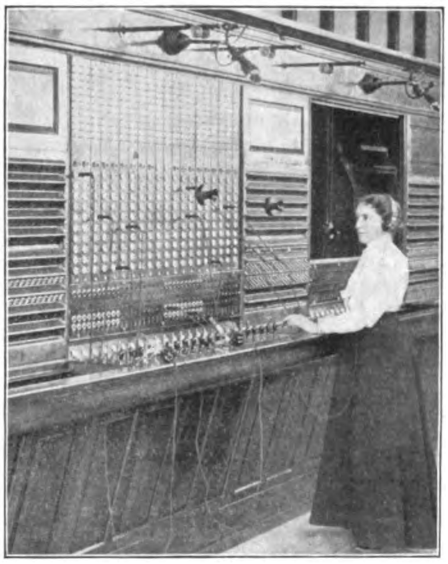


FIG. 4.—TRUNK PLUGS CARRIED OVER.

Either subscriber can control his own lamp signal by moving his switch hook, and when both have hung up their receivers both line lamps are lighted for clearing out. If one lamp only should light, it would either be a sign of trouble or indicate that one subscriber had neglected to hang up his receiver, the operator then taking the usual steps to apprise him of that fact.

If the wanted line is not within reach, the "A" operator inserts the calling plug in the jack of a trunk leading to the desired section, at the same time pressing the corresponding order-key and repeating the number to the "B" operator, and pulling the knob of her combination key as before. The "B" operator takes the proper trunk plug and inserts it in the desired jack. The instant she has done so a circuit is completed for the supervisory signal in front of the "A" operator, who is thereby informed that the connection is complete and proceeds to ring. There need be no delay in the "A" operator's work, because of a slight delay in the completion of the connection; for the lighting of that lamp always means the same thing—that is, she is to ring, and the order cannot be lost, for the "B" signal will bring the "B" operator back on the order circuit if she has missed it. When the subscriber answers, the supervisory lamp goes out, and when the conversation is finished the clearing-out signals are received at both ends as before.

In case a line is busy, that is, if the "B" operator finds a plug already in the jack, she speaks directly to the calling subscriber through the trunk wire, informing him that the line is busy, and in hanging up his receiver he gives the clearing-out signal; or should he neglect to do so the "B" operator can directly inform the "A" operator of the fact.

This system is provided with an arrangement of multiple trunks, instead of the simple trunking described, where trunking between exchanges is to form a considerable percentage of the business. For this purpose a set of busy signals are used in addition to the supervisory signals shown. The desk at the left-hand side of Fig. 1 is a monitor's desk, fitted with listening keys only, so that the monitors can listen to or talk with any operator or the chief. In the complete designs, where conditions permit it, this desk is also fitted with a distributing board for all the operators' circuits, and "on and off" keys giving control of the individual operators, battery connections, to insure economy. The chief operator's desk is also fitted with a limited number of special line units, whereby habitual "kickers" among the subscribers can be accommodated by the chief herself.

One of the most interesting points about the Atlanta installation is the provision of automatic tests for almost all troubles. In case of grounds or crosses on the lines the troubles report themselves at once; in case of a subscriber leaving his receiver off the hook or of a supervisory relay failing to work, a white or a red lamp lights, as the case may be; and generally it may be said that this system makes the trouble man's work easy.

In an article of this kind it is manifestly impossible to go into all the details of construction and of the circuits of a large exchange. It will perhaps be not out of place to say that all of the features described herein are substantially covered by patents or by claims in applications that are the absolute property of the Sun Electric Manufacturing Company. This switchboard, and others that have grown out of it, are the results of long-continued original work, in which special care has always been taken to avoid encroaching on the rights of others, and the same care exercised to insure self-protection.

The service possible with a system of the kind described is very rapid, as a year's experience has demonstrated, approaching within one second average time of that possible on the most modern multiple boards. The expense of operating, taking everything into consideration, is almost the same, and the following advantages are perfectly apparent: Lower cost of installation; absolute simplicity of parts and of circuits; perfect accessibility of every part of the apparatus and of the wiring, from the cable heads up; proper apportionment of the weight and bulk of cables and racks where they belong, around the walls of the exchange and not on the switchboard; interchangeability of parts; and finally, the possibility of almost instantly being able to take out any part or any aggregation of parts in the entire exchange, without exception, and to replace it by another, without interruption of the service.

ANNUAL MEETING OF THE ENGINE BUILDERS' ASSOCIATION.

The Engine Builders' Association of the United States held its annual meeting on December 4 at Sherry's, corner Fifth Avenue and Forty-ninth Street, New York City. Three extremely interesting papers were read before the meeting, one by Mr. H. C. Ebert, of the Westinghouse Company, on "Inter-relations Between Engine and Generator Builders"; one by Mr. E. J. Armstrong, of the Ball Engine Company, on "Economy Guarantees of High-Speed Simple Engines," and the other by Mr. H. G. Reist, of the General Electric Company, on "Some of the Requisites of Modern Lighting Generator Sets."

Mr. Ebert, in his paper, stated that as purchasers continued to express a strong preference for direct-current apparatus his paper would deal specifically with the subject of the so-called engine-type generating sets. He proceeded to point out that when a consulting engineer makes the specifications for the generators and engines he usually designates an engine which will closely correspond with the generator in capacity, speed and regulation, but when the selection of an engine to drive a certain size of generator is made by the purchaser himself an engine is invariably obtained which in these three important features does not match the electrical part of the outfit. It is in such cases, he said, that both engine and generator builders find great difficulties. There should be uniformity in rating engines with regard to the overload capacity of the generator to be driven. It should be noted that what would be considered ideal regulation for a direct-current installation would not be satisfactory with alternating-current power generators. If the governors on two engines driving alternators tend to give different speeds, say 500 and 525 r.p.m. respectively, no matter with what regularity the engines may run the two alternating-current machines will not operate satisfactorily in parallel; the one which runs at the higher speed carrying all the load.

There would seem to be no good reason, he continued, for dissension or disagreement if the builder who is to furnish the engine and the one who is to furnish the generator will acquaint each other with the general terms of their contract with the purchaser, so far as those terms relate to characteristics held in common by both the generator and the engine. Mr. Ebert strongly commended the work of the committees on "Standards for Direct-Connected Generating Sets," appointed by the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, and predicted as a result of the joint labors of these two committees the elimination of many minor troubles which are now experienced.

He outlined the Westinghouse Company's practice in direct-connected generator outfits, which included calling the attention of the engine builders to the magnetic attraction between the field magnet and the armature core and stating on the drawings the amount of magnetic pull which may be expected should the armature become decentralized. As this unbalanced magnetic pull acts at right angles to the shaft and may be in any radial direction parallel with the plane of revolution it should be carefully considered, not only with regard to the shaft diameter but also the strength of the foundation, sub-base, and housings on the main bearings. The connection between the outboard bearings and the sub-base should be particularly rigid. In one or two instances wherein this magnetic attraction was not taken into consideration by the engine builder the result was the almost total destruction of both engines and generators.

Mr. Ebert also stated that Westinghouse engine-type generators for both direct-current and alternating-current power work were designed to be connected to the engine in any one of the following four ways: First, the revolving element of the generator may be pressed and keyed on an extension of the engine shaft, the engine builder furnishing the shaft, keys and outboard bearings; second, the generator may be self-contained and include the shaft, shaft keys, outboard bearing and half of a flange coupling for bolting to a similar half coupling on the end of the engine shaft or side of the flywheel; third, the revolving part may be designed with a flanged extension for direct connection to the flywheel, the shaft on which this revolving element is pressed or keyed may or may not be a part of the engine shaft; fourth, machines of 850 kilowatts and over can be built with bosses on the spider arms for bolting direct to an extension on the engine flywheel. In any case the Westinghouse Company provides the necessary gauges and templates to enable the engine builder to properly fit the connecting parts of the engine.

Mr. Bird, of the Ball & Wood Company, said that pressing on armatures was a great inconvenience, and that it was not always clearly understood who should do the work, the engine builder or the generator builder. He said that his company's practice was to bore a hole in the end of the shaft of a uniform size and to use a stud bolt to insure a fit. Mr. Ebert expressed approval of this practice, and suggested that its general adoption would probably be welcome to electrical manufacturers. Regarding the question of overload capacity, Mr. Ball agreed with Mr. Ebert that this question was a serious one; the electrical engineer, he said, was largely to blame for making some plants unnecessarily costly and frequently preventing a would-be purchaser from putting in a plant because of the high cost imposed by the practice of encouraging the purchaser to ask for a larger overload capacity than his actual need justified. Mr. Ball suggested that there should be a limit placed on the overload capacity to be specified. Mr. Ebert said that this would probably adjust itself, that the Westinghouse Company had already reached a point of refusing to agree to more than 50 per cent overload capacity, and were doing all they could to keep down the demand for excessive specifications in that direction.

Mr. E. J. Armstrong, in his paper on "Economy Guarantees," pointed out that the matter of economy does not always receive due consideration. An engine that runs smoothly, noiselessly and reliably will have friends and purchasers whether it uses much or little steam. He had no desire to advocate improvement in economy to the neglect of other essential qualities, but he believed that many engine builders have only an imperfect idea of the capability of their own engines. He thought that if the subject was amenable to a greater extent to mathematical treatment the case would be different, but in spite of the marvelous advancement in science at the end of the century, he believed that the exact formula for the economical performance of the steam engine had yet to be written. In view of the fact that the steam used by an engine often costs as much per year as the engine itself it would seem that the purchaser might consider steam economy as of first importance and price as a bad second; yet, even a small difference in price or a personal preference will decide a purchase without raising the question of economy at all. A difference of 10 per cent in steam consumption between two engines might easily place the more wasteful one in the position of being too expensive, even as a gift, for installation, but there is no doubt that there have been and still are even greater differences than this between engines that are sold on equal terms. Mr. Armstrong expressed the belief, however, that this condition of things would be brought to an end in the early future. For years, he said, there had been an increasing tendency among purchasers to raise the question of economy, and engine builders must recognize and prepare to meet a demand for definite guarantees and performances.

It is not usually practical to test engines of small size after installation; the expense is disproportionate and the difficulties in the way of obtaining accurate results are great. The liability to error and the impossibility of running preliminary tests make it unsafe to make close guarantees which are to be demonstrated in this way. The proper place to test an engine is on the shop testing floor. The question of penalties for failure to meet the terms of contract is considered quite onerous by engine builders, but if not provided in the contract, the only penalty is the non-acceptance of the engine; and as this is often impracticable because of lack of time, there is a good chance that the guaranty is not worth anything. Definite penalties at least have the effect of protecting those who really make their guarantees in good faith and with a knowledge of what they can do. There is nothing wrong about it from the purchaser's standpoint. There is one feature of the situation that is manifestly unfair and calls for remedial action. Better economy costs money. It may not actually cost more to build a high-duty engine than a wasteful one, but it costs a good deal more to learn how and to keep up the standard afterward. It costs money to tune an engine up to meet a close guaranty, and testing engines is an expensive business at the best. There should certainly be an addition to the price when guarantees are required. Mr. Armstrong suggested that all duty guarantees should provide for their fulfillment on the shop floor test before shipment and should always be considered as an extra, it being optional in all cases with the purchaser to accept the proposal with or without the guaranty. If the guaranty does not mean anything, it should not be made. If it does stand for something it costs a good deal and is worth to the customer all that he is likely to be asked for it.

Mr. H. G. Reist, in his paper on "Requisites of Modern Lighting Generator Sets," pointed out that it is not possible to adopt absolute speeds for engines which are used to drive alternating-current generators direct, because of the various frequencies employed in different classes of work, and because the generators must be built with a number of poles that is divisible by four. Mr. Reist proceeded to explain the relation between the frequency of the circuit and the revolutions per minute of the generator, and argued that by a careful selection of sizes it would be feasible to keep down the number of designs to a great extent and thus facilitate the duplication of the designs adopted. The General Electric Company had given considerable thought, he said, to the selection of a range of sizes, and had concluded that if the units adopted were of such size that each one was 50 per cent larger than the one below it there would be a sufficient number of large machines to meet all requirements. Mr. Reist said that this conclusion had been sustained by practical application of lines of generators and motors with the sizes spaced approximately according to this plan. This method of determining the sizes, he admitted, necessitates giving some of the machines odd ratings, but this would occur in any case with either the engine or the generator, as one is rated in horse-power and the other in kilowatts.

Referring to the operation of direct-driven alternators in parallel, Mr. Reist stated that all engines designed for this service should not have an angular deviation from absolutely uniform speed of more than $\frac{5}{P}$ degrees of a cycle, P being the number of poles on the machine. The principal trouble experienced in operating alternators in parallel, he said, is due to the variation in speed of the prime movers, which causes hunting and the exchange of wattless currents between the generators.

Mr. Stett suggested that it would be well for dynamo builders to specify more exactly just what would be required of the engine in regard to the speed variation in each case. Mr. Stett also brought up the question of getting plans more promptly from manufacturers so that the engine builders could have more time on their work. Mr. Ebert said that if no special designs were called for, the plans could be given quickly, but many special machines had to be built and they naturally were hindrances to getting out the plans promptly. Mr. Wood made a motion that the committee from this association should meet similar committees from other associations concerned and take the matter up thoroughly.

At the close of the executive session, Mr. W. M. Taylor, of the Chandler & Taylor Company, extended an invitation to the association to meet next year at Indianapolis, and the invitation was accepted. In the evening a dinner was served at Sherry's, which was thoroughly enjoyed by about 35 members and guests of the association.

Abstracts from Foreign Contemporaries

An Arc Lamp with a Nernst Effect.—An interesting description of a Bonhivers arc lamp recently appeared in the "Zeitschrift fuer Beleuchtung." The two carbons of the lamp approach each other at an angle somewhat less than 180°, and in close proximity to a block of refractory material which is brought to a very high temperature by the arc, and radiates a light of a quality similar to that of a Nernst lamp. The refractory material of which the block is made consists of 52 per cent of burnt clay, 26 per cent of raw clay, 12 per cent of powdered quartz, and 10 per cent of boracic acid.

Luminous Electric Radiators.—The accompanying engraving, Fig. 1, taken from the London "Electrician," illustrates the latest pattern of Dowsing electric radiator. The apparatus consists of a bright copper framework resembling somewhat an open firegrate, and containing four incandescent lamps having candle-shaped bulbs. The copper sheet back of the lamps serves the double purpose of a reflector and a radiator, the construction of the apparatus being such that a current of air can pass up behind this sheet and out into the room.

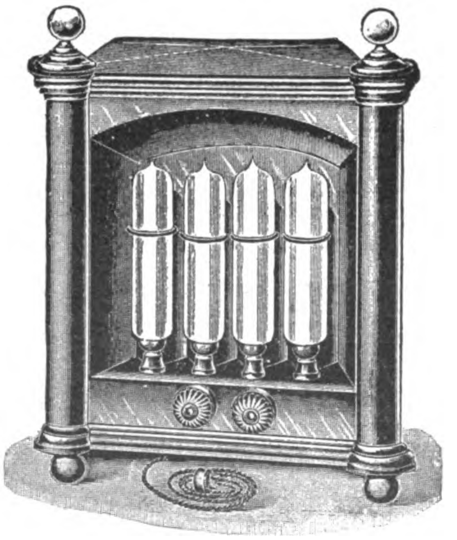


FIG. 1.—LUMINOUS RADIATOR.

Reflector Incandescent Lamps for Street Lighting.—A recent issue of the London "Electrician" has an illustrated description of a rather interesting type of incandescent reflector lamp which is used for street lighting. Fig. 2 herewith illustrates an ordinary gas lantern equipped with two of these lamps. As the illustration shows, the bulb is shaped somewhat like the familiar McCreary shade, and the upper half serves as a reflector by reason of a silver deposit on the outside of the bulb, which is protected from the action of the weather by a coating of copper deposited directly on the silver film.

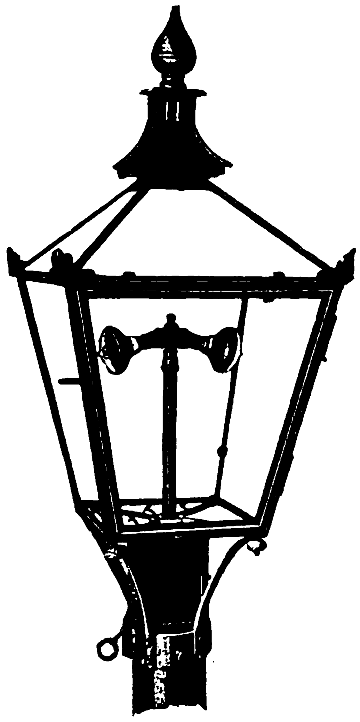


FIG 2.—STREET LANTERN.

Surface Contact Railway Systems.—In recent issues of London electrical papers there has been published a description of the Schuckert surface contact system, which has been in successful use on some of the railway lines in Munich since the summer of 1899. The road-bed is provided with a central row of contact studs with automatic switches for connecting these studs with the live feeders when the car is over the studs, and disconnecting them when it has passed. Fig. 3 is a diagram of the car connections, and Fig. 4 a general scheme of the system. There is no mechanism beneath the road-bed proper, the contact stud switches being grouped in sub-surface pockets along the side of the track. The cars are provided with skates, of course, which make contact with the track studs in the usual manner. The electromagnetic switches, as an inspection of Fig. 4 will make clear, are so arranged that a shunt circuit from the last stud already in contact with the skate energizes the relay which connects the next contact stud ahead of the skate with the feeder circuit. Following behind the skate is a short-circuiting brush which sweeps both the contact studs and the rails. (The rails are used as a return conductor, as in the case of an ordinary trolley system.) The object of the short-circuiting brush is to prevent any of the studs from being left alive. In the event that the release mechanism fails to act after the skate has left the stud, the short-circuiting brush comes along and connects the stud with the rails, putting on a dead short-circuit which throws an automatic circuit-breaker in series with the stud. The total cost of the installation is said to be about twice as great as the ordinary trolley system with steel poles, and about 1-3 of the cost of a consolidated conduit system.

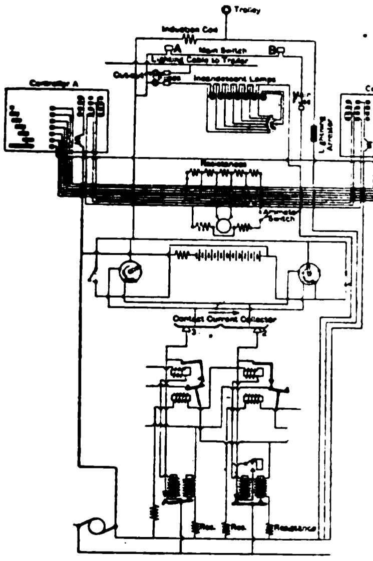


FIG. 3.—SCHUCKERT CAR DIAGRAM.

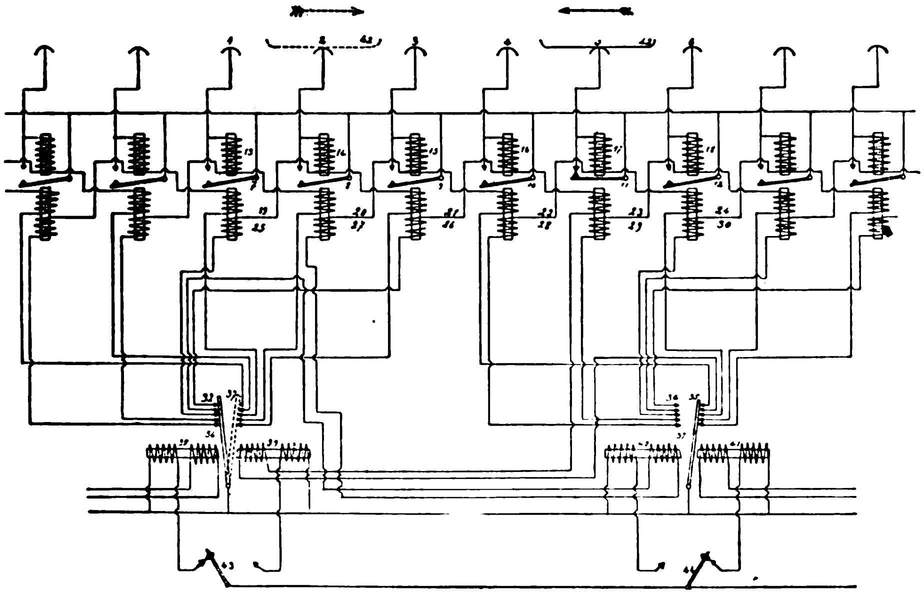


FIG. 4.—DIAGRAM OF SCHUCKERT SURFACE-CONTACT RAILWAY SYSTEM.

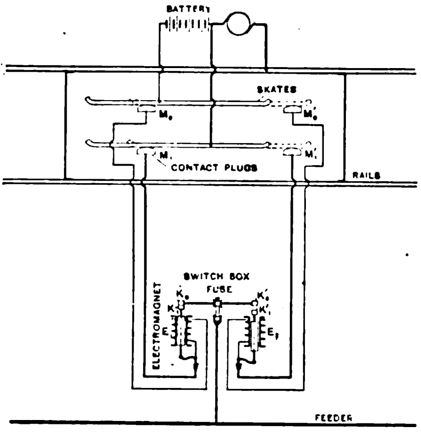


FIG. 5.—HELIOS SYSTEM.

An illustrated description of the surface-contact system of the Helios Company, which is somewhat similar to the Schuckert system described above, is illustrated in the "Elektrotechnische Zeitschrift." This system includes contact studs or knobs between the rails and skates on the cars, exactly like the Schuckert system, except that there are two lines of contact studs and two skates on each car. There are also distributor boxes at intervals along the side of the road-bed containing relay switches which connect and disconnect one line of contact studs with and from the feeders. The electro-magnetic switches, however, are operated by a storage battery on the car. The connections are shown in Fig. 5; one set of contact studs, M_0, is for the storage battery and relay connection, the electromagnetic switch being restored by a spring when the battery skate breaks the connection under the car.

Motors for Machine Shop Service.—In a long serial on the driving of machine tools by individual motors, which appeared in recent issues of the "Elektrotechnischer Anzeiger," O. Lasche, discussing the arguments which have been advanced against individual motors, says that comparing the current consumed by individual motors with that taken by motors which drive groups of machines, the group system shows better economy only when all of the machines are deliberately run at the same time under maximum load. In practice, however, where the load does not average anything like its maximum value, it has been proved by experience that individual motors are more economical. Regarding the first cost of equipment, Mr. Lasche, taking as an example an installation of 61 machine tools, estimates that the first cost of the plant with individual motors (assuming that the building has already been erected) is only 2.3 per cent higher than the cost of the group system. And where the building has not already been erected this advance will be reduced by reason of the fact that the individual motor system does not require a building with such strong walls as the other.

A New Storage Battery Plate.—A peculiar type of Plante or formed storage battery plate, which constitutes the positive electrode of the Omega storage battery, is described by P. Weber in a recent issue of "Centralblatt fuer Accumulatoren und Elementenkunde." The plate consists of a central web of zigzag cross-section, as shown in the lower part of Fig. 6, on each side of which are provided wings which constitute the positive plates. The object of this arrangement is to allow the plates to expand in any direction so as to avoid buckling. The process of forma-

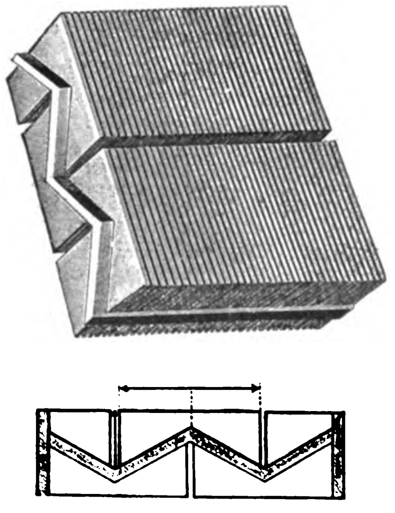


FIG. 6 —OMEGA BATTERY PLATE.

tion is not described; the author states that a special process is used which requires only three days' time for forming and which does not involve the use of any chemicals that can subsequently prove detrimental to the battery.

Direct Current vs. Polyphase Currents.—A general comparison of direct and three-phase currents for plants of medium size was made by H. A. Earle in a paper read before the Manchester section of the British Institution of Electrical Engineers recently. Mr. Earle made the usual comparison of copper required for transmission lines and pointed out the disadvantages of polyphase motors for use where speed regulation is required. He also alluded to the exaggerated bugbear of commutator trouble, showing that the objection to the commutators of direct-current motors in surroundings where sparking might cause an explosion was entirely overcome by the modern wholly-enclosed direct-current motor. The paper contains an interesting comparison of direct-current and polyphase motor efficiencies. Mr. Earle made tests of a large number of both types of motors and plotted the results in the shape of a curve. The principal results are given below:

EFFICIENCIES.

Brake H.-P......	3½	6	10	25	50	100
Direct current..	82%	85%	86%	91%	92%	92%
Polyphase	75%	80%	84%	88%	90%	91%

Regarding the railway motors, he pointed out that while polyphase motors appeared especially suitable for long lines of railway where distances between stops are considerable, such a system is unsuitable for use in towns where frequent stops and a variable rate of speed are required. He did not point out, however, one of the strongest disadvantages of the polyphase system for railway traction, viz., the lack of interchangeability between a system of this sort and the prevailing direct-current system, which would prevent the cars of one system from operating on the tracks of the other.

Induction Motors as Generators.—In a translation of a paper read by Mr. Maurice Leblanc before the Societe Internationale des Electriciens, which recently appeared in the London "Electrical Review," is described an induction machine designed for use as a generator. The machine has practically two distinct stators mounted concentrically about a single shaft, as represented in Fig. 7, where CC is one stator and EE the other. The laminated stator core, CC, is provided with a single-phase primary winding. On the shaft are mounted two distinct laminated cores, DD, and FF, bar-wound after the fashion of ordinary induction motors except that the windings of the two cores are interlinked, as shown by the diagram, Fig. 8. The stator core, EE, is provided either with several exactly similar circuits angularly displaced with reference to each other, as in the case of an ordinary polyphase induction motor, or a continuous closed-circuit winding, such as would be used for the stationary armature of a direct-current revolving-field machine. The functions and operations of the various parts are as follows: The winding of the stator, CC, is excited in the usual manner and induces alternating current in the rotor winding on the core, DD. This winding delivers current to its duplicate winding on the core, FF, which in turn induces currents in the windings on the stator core, EE. The machine obviously requires no sliding contacts or collector rings whatever, and its speed for a given frequency is only one-half that of a generator of ordinary construction.

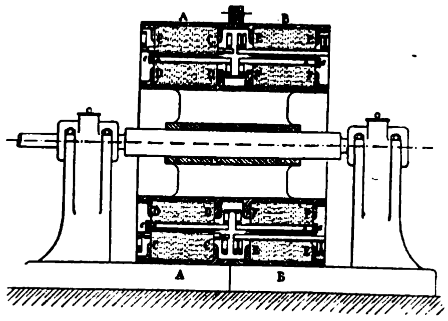


FIG. 7.—LEBLANC INDUCTOR ALTERNATOR.

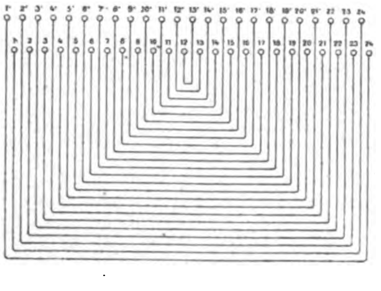


FIG. 8.—ROTOR CONNECTIONS.

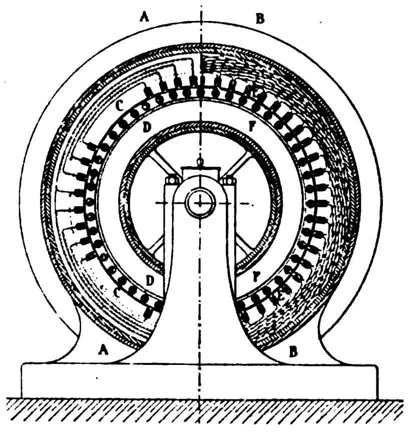


FIG. 9.—SIDE VIEW OF ALTERNATOR.

Electrical Central Station Service.—At a meeting of the Glasgow section of the Institution of Electrical Engineers, W. A. Chamen read a paper on "Electricity Supply," in which he advocated the use of low-tension direct-current, generated on a site within the area of supply, if possible, and supplemented by a small amount of high-tension apparatus in order to reach remote distribution points. If it is impossible to obtain a supply within the area of distribution at a reasonable price and with railway accommodations, then a high-tension system with the generator station outside of the distribution area is the next best argument. Mr. Chamen favors a three-wire system of distribution with 500 volts between the outer wires, as this would allow the use of a uniform maximum e.m.f. for both lighting and traction. He stated that in Glasgow, where such a system is used, 250-volt incandescent lamps of as low as 5 and 6 candle-power have been in use for over fifteen months without failure. The efficiency of the lamps is 5 watts per candle for the sizes named; 4 watts per candle for 8-c.p. and 16-c.p. lamps; 3½ watts per candle for 32-c.p. lamps; and 3¼ watts for 50-c.p. lamps.

Regulation of Rotary Converters.—It is well known, of course, that the direct-current e.m.f. of a rotary converter cannot be regulated by adjusting the field strength of the machine. The method usually employed in this country for regulating the direct-current voltage is to insert an induction regulator in the alternating-current leads, and by means of this vary the alternating-current e.m.f. impressed at the collector rings. The method used by the Allgemeine Elektricitäts Gesellschaft of Berlin for this purpose is described in a recent number of the "Elektrotechnische Rundschau." Fig. 10 herewith illustrates diagrammatically the arrangement. On the same shaft with the converter armature is mounted an ordinary alternator armature, R, wound for the same number of phases as the converter armature and connected in series between the alternating supply and the converter armature windings. The auxiliary armature, R, rotates within a field magnet, M1, having the same number of poles as the field magnet, M, of the converter, and excited from the same source. It is obvious that the auxiliary machine acts merely as an alternating-current booster. It is also evident that the fields and armature windings of the two machines must have fixed relations with each other in space in order that the phase relations may be symmetrical. If it is desired to have the rotary converter compounded so that the direct-current e.m.f. will rise as the function of the load, the field magnet of the auxiliary machine may be provided with only a heavy wire winding connected in series with the direct-current load, just as the compound coils of a direct-current generator are connected.

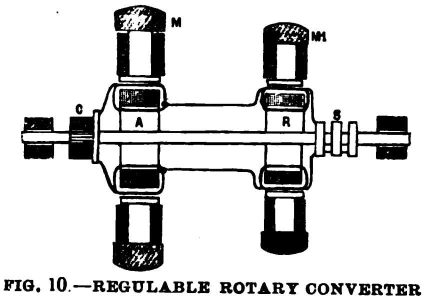


FIG. 10.—REGULABLE ROTARY CONVERTER.

Electric vs Steam Locomotives.—In a paper recently read before the British Institution of Electrical Engineers. W.

Langdon discussed very conservatively the relative merits of the electric locomotive and the steam locomotive for trunk line service, basing his comparisons on three-phase transmission between generating stations and rotary convertor sub-stations for the electric system. Taking the 50-mile Midland railway between St. Pancras station (London) and Bedford, and assuming a motor efficiency of 85 per cent, a transmission efficiency of 90 per cent, a conversion efficiency of 84 per cent, and a distribution efficiency of 87 per cent, Mr. Langdon showed that the cost of working with electric locomotives would be 14.04 cents per train-mile, as compared with 17.85 cents per train-mile for steam locomotives. He pointed out that in the case of the adoption of electric traction by a company already established and using steam locomotives, the additional expense due to the change would unavoidably prove for some years an addition to the company's capital charges, but that for a new company it would not be necessary to take into consideration the interest of the entire additional outlay necessary for the electrical plant, because there would be considerable saving in first cost in other directions.

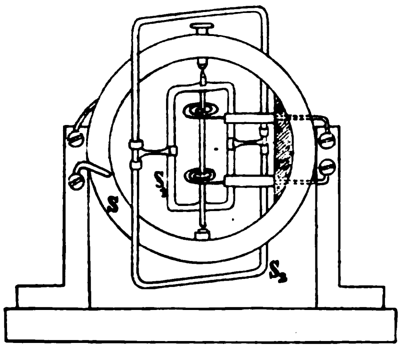


FIG. 11.—ASTATIC WATTMETER.

An Astatic Wattmeter.—The "Elektrotechnische Rundschau" recently published a description of a new Hartmann & Braun astatic wattmeter for use on direct-current and alternating-current circuits. Fig. 11 herewith, which has been reproduced from the journal mentioned, indicates the principle of the apparatus. The current coil, S, is fixed to the framework of the meter, and there are two potential coils, S1, and S2; the inner one mounted on pivots, as shown, and the outer one supported by struts from the inner coil. The two potential coils are connected in the usual manner common to all astatic instruments, so that the current circulates in opposite directions through them, nullifying the effect of the earth's magnetic field. As the arrangement shown by Fig. 11 involves some difficulties in practical construction, the coils of the actual instrument are made up as in Fig. 12, which shows three potential coils, one of the fundamental pair being divided into two sections.

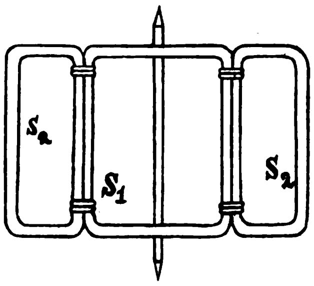


FIG. 12.—WATTMETER COILS.

Some Recent Electrical Patents

Insulating Knob.—Several forms of knob insulators have been devised, the object of which has been to provide a means for attaching wires to the knob without the use of separate tie wires. One of the most recent devices of this sort is illustrated in Fig. 1. The body of the insulator knob is of the ordinary shape, but the portion below the groove is extended on one side into a lip, or hook, A, the function of which is made clear by the engraving. Patent No. 660,271.

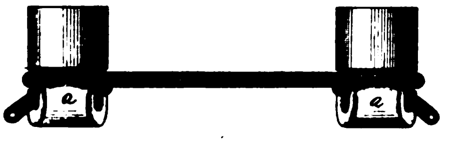


FIG. 1 —INSULATOR KNOB.

Distribution System for Rotary Converters.–It is well known that when two or more rotary converters or synchronous motors are supplied from one distribution system there is a liability to hunting, which is greater if the natural periods of oscillations of all of the machines are identical, as would be the case if the machines were all of one size and type. With a view to obviating this tendency to hunting, E. J. Berg, of the General Electric Company, has devised the arrangement shown diagrammatically by Fig. 2, in which the supply generators are represented by A, the step-down transformers by T, the rotary converters by R, and the direct-current mains, which are fed by the rotary converters, by E B. The alternators supply bus-bars, D, in parallel in the ordinary manner, and from these bus-bars individual feeders, E, F and G are carried to the respective transformers. At the transformer end the feeders are cross-connected by means of equalizing wires, C, C, C, of extremely low resistance. It is the provision of these equalizing wires which is expected to overcome the tendency to hunting, the inductive character of the circuit acting to oppose the interchange of wattless currents, and the low resistance of the conductors serving to equalize the electromotive forces of the machines. Patent No. 666,483.

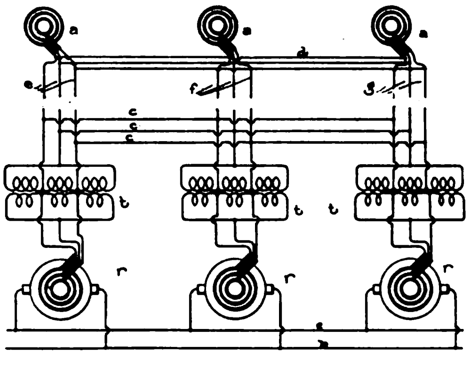


FIG. 2.—ROTARY CONVERTER CIRCUITS.

Alternating-Current Distribution.—It is frequently desirable in the operation of polyphase alternating-current systems, for the purpose of balancing, to transfer portions of the load from one phase to another of the system. A simple method of accomplishing this has been patented by E. M. Hewlett, of the General Electric Company, and is illustrated diagrammatically by Fig. 3. In the diagram, 4 represents a three-phase transformer supplying mains, 1, 2, and 3, of a three-phase circuit, from which are tapped off two-wire single-phase branches, 13, 14 and 15. Each of these single-phase branches is controlled by two single-pole double-throw switches, which enable the operator to connect any single-phase branch to any pair of the three-phase mains. In the diagram, branch 13 is connected between mains 1 and 2, and throwing the upper switch over to the left would connect it to mains 1 and 3, as branch 14 is connected; branch 15 is connected to mains 2 and 3. Patent No. 660,815.

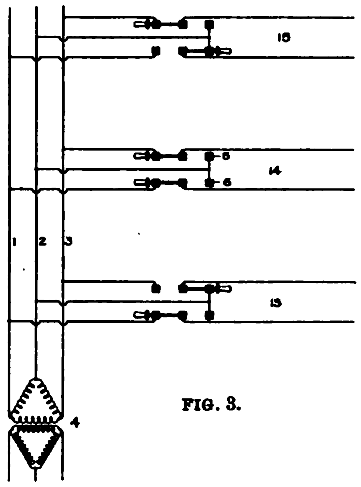


FIG. 3.

Arc-Lamp Carbon-Holder Contact.—The advent and widespread adoption of the enclosed-arc lamp seems to be responsible for the employment of the upper carbon fed from a stationary tube, sometimes without any upper carbon holder and sometimes mounted in the end of a thin tube sliding within the stationary tube. A disadvantage of this construction is the difficulty of making contact between the carbon and the stationary part of the lamp without retarding the feeding of the carbon or rendering it uncertain. With a view to overcoming this difficulty the device shown by Fig. 4 has been patented by George E. Stevens and assigned to the General Electric Company. The engraving is almost self-explanatory. The carbon, G, is mounted in the end of the carbon tube, H, containing a plug, A, on which are mounted four spring arms carrying rollers in their bifurcated ends. The spring arms tend to press the rollers outwardly through the slots, H′, in the movable tube into contact with the wall of the stationary tube, F. The object in extending the movable tube, H, up beyond the rollers and cutting slots in its wall, through which they protrude, is to restrain the outward movement of the spring arms when the carbon tube is removed from the guiding tube in order to facilitate the replacement of the carbon tube by the trimmer. A lug, F^1, is provided at the upper end of the stationary guiding tube, F, to limit the upward movement of the carbon tube, H, and prevent the rollers from passing the upper edge of the stationary tube and hanging up the carbon. Patent No. 659,711.

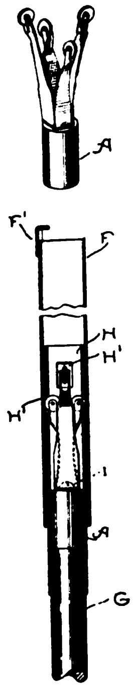


FIG. 4.

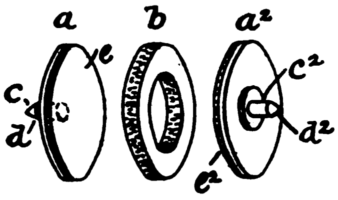


FIG. 5.

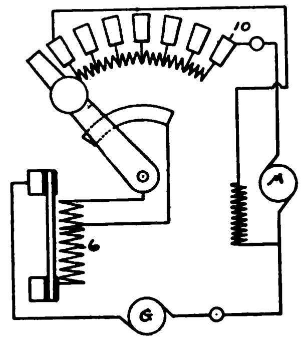


FIG. 6.

Telephone Transmitter.—A patent has been issued to George B. Perkins for a granular-carbon telephone transmitter in which the current-varying device is constructed as shown by Fig. 5, where *a* and *a2* are thin metal discs each having a pointed spindle, *c* and *c2*, projecting from the center at right angles to the disc. A thin disc of carbon, *e*, is attached to the opposite face of each plate and covers the whole surface. Between the two plates is mounted a ring, *b*, of felt or similar material, which forms a chamber for the granulated carbon. One face of the felt ring is cemented to one of the carbon discs, *e*, and the granulated carbon is poured into the chamber formed by the center of the ring. Then the other carbon disc, *e2*, is cemented to the face of the ring, *b*, completely enclosing the granulated carbon. When the button is thus assembled one of the pointed spindles enters a seat in a small metal button in the center of the transmitter diaphragm and the other spindle enters a similar seat in an adjusting screw by means of which the pressure is regulated. Patent No. 659,691.

Motor Starter and Circuit-Breaker.—One of the objections which has long been urged against the use of circuit-breakers instead of fuses as protective devices for electric motors is that the circuit-breaker must be set to withstand a current flow which is considerably beyond the maximum ability of the motor in order to prevent opening the circuit by the rush of current which occurs when the motor is started up. Time-element circuit-breakers have been proposed to meet this difficulty, and are used in other cases, but have not come into use in connection with motors of ordinary size because of their expensive construction. Fig. 6 represents diagrammatically an arrangement which has been patented by W. M. Scott for the purpose of obviating the difficulty. The circuit-breaker winding is indicated by 6, the motor being indicated by the letter M, and the generator or source of current by G. The circuit-breaker coil is shown divided into two sections, one of which is cut out by the rheostat lever until the contact brush has reached the final contact button, 10, at which time the motor is presumed to be running with normal current, and the whole circuit-breaker coil is thrown in. This arrangement evidently raises the limit at which the circuit-breaker will be thrown until the rheostat arm reaches the running position, when the point of operation for the circuit-breaker is lowered by reason of the added winding. The patent describes other methods of accomplishing the same end, such as shunting the circuit-breaker coil until the rheostat arm reaches the running position. Patent No. 661,196.

◆

NEW BOOKS.

High-Speed Steam Engines. By Wm. Norris and Ben H. Morgan. London: P. S. King & Son. Cloth, 150 pages, 5½ x8½ ins.; 115 illustrations. Price, $2.50.

The character of this book, with the exception of a short introductory section on the development of the high-speed engine, is entirely descriptive. The leading types of British engines are well described and the text is adequately illustrated. The section on American high-speed engines is sadly deficient. Ten pages are devoted to the Westinghouse engine, two-thirds of which might have been logically occupied by descriptions of some of the representative engines that are not even mentioned, notably the McIntosh & Seymour, Erie Ball, American Ball and Skinner. The descriptions of the American engines that are given are not at all comprehensive, with the exception of the Westinghouse and Ideal engines, which are very fully treated. As an exposition of English practice, however, the book is extremely creditable.

Engine Tests. By Geo. W. Barrus, S. B. New York: D. Van Nostrand Company. Cloth; 335 pages, 6 x 9 ins.; 146 indicator diagrams; 1 chart. Price, $4.

This book is a fitting companion to Mr. Barrus' "Boiler Tests," being of precisely the same character. The book contains records of results from more than a hundred tests of engines and a full explanation of the methods employed in making the tests. The list of engines tested includes every type commonly used, from the simple non-condensing single-valve kind, of 25 horse-power, to four-valve compound and triple-expansion engines of 1000 to 1500 horse-power. Besides the tests for steam consumption there are two extremely instructive chapters on Valve Setting and Steam-Pipe Diagrams, both profusely illustrated by indicator diagrams. The book is almost indispensable to steam engineers who are even casually interested in steam-engine performance.

Electrical Units for Boys. By Arthur A. Kent. Lebanon, N. H.: Kendrick & Davis. Paper; 32 pages, 3 x 3½ ins. Price, 10 cents.

This is an elementary little pamphlet written for the benefit of boys who are interested in electricity. The scope is restricted to an explanation of the fundamental electrical units and a short discussion of magnetism and small electric motors.

◆

NOTES.

Trolley Mail Cars.—In Grand Rapids, Mich., all mails are transported between the railroad stations and the post-office on trolley cars, and these electric mail cars also constitute traveling mailing stations, a letter box being attached to the guard of the front platform of each car. When anyone wishes to mail a letter he simply stops a passing car and drops the letter in the box. The system has been found of great advantage in cases of urgent letters directed to remote parts of the city and mailed too late for the last regular collection by carrier.

Electric Railway Development in Connecticut.—The electric street railway track mileage of Connecticut has increased from 100 miles in 1890 to 500 miles to-day. Then there were 15 horse railways in the State, and to-day there are 33 individual street railway corporations, and these have absorbed some 50 smaller roads. There is a continuous trolley line from Westchester County, N. Y., along the Sound shore to Branford, and branch systems have been built up the Naugatuck Valley northward for 20 miles, to New Haven, and up the Hartford line to New London. Cross-country lines connect these systems and gridiron practically all of the most important sections of the state. It is scarcely necessary to explain that electric traction is responsible for these developments.

Electric Railway Up Mont Blanc.—An electric railway to the summit of Mont

Blanc is projected. The plan which is favored contemplates starting a line from Les Houches on the Savoy side, 11 miles below the summit. It is proposed to provide twelve stations, each fully equipped with every convenience for travelers. The project includes a power house on the river Arve, which now furnishes power for the electric road up Mont Saleve, on the edge of Geneva.

Northwestern Electrical Association.—The ninth annual convention of the Northwestern Electrical Association will be held at Hotel Pfister, Milwaukee, Wis., beginning on the morning of January 16. Papers will be read on subjects of particular interest to central station engineers, and the hotels and railroad companies have made special rates, for delegates to the convention. Complete particulars regarding rates, etc., may be obtained from Mr. James Wolff, 320 Dearborn Street, Chicago.

Another Moving Stairway for the Manhattan Elevated Road.—The Manhattan Elevated Railway Company has installed a second escalator or moving stairway in its system, the new escalator being located at the 23d Street station of the Sixth Avenue road. There are 32 steps and the machine moves at 72 ft. a minute, at which rate its capacity is 4500 passengers an hour. It can be speeded up to 90 ft. a minute, giving it a capacity of 7500 passengers an hour. The apparatus was installed by the Otis Company.

The Riker Motor Vehicle Company Absorbed.—The Electrical Vehicle Company has bought up the entire capital stock of the Riker Motor Vehicle Company, which was its most formidable competitor, and has bought also from Mr. Riker personally all his foreign patent rights, the Riker Company having owned only the United States patents. The Riker plant at Elizabeth, N. J., will be continued. This deal puts the Electric Vehicle Company in a much stronger position than it previously occupied, Mr. Riker's patents being of a very important character and his experience most valuable.

A Point in Central Station Working.—The policy of the St. Joseph (Mo.) Railway Light, Heat and Power Company of selling exhaust steam for heating purposes recently developed an interesting point in central station operation. The company's station is located on the Missouri river, where condensing water is easily available, but the plant is run non-condensing and the exhaust steam is sold for heating purposes, although the income from this service is just about sufficient to pay for the additional coal required to run non-condensing instead of condensing. The question was naturally asked why it would not be better to save the additional coal handling and simplify the distributive system of the company by running condensing; whereupon it developed that by supplying exhaust steam for heating to large buildings, the company could also get the contract for lighting, whereas if the heating service was not supplied, the large buildings having to put in a boiler and pumping equipment for heating purposes would naturally add an electric lighting plant. During the summer months the engines will run condensing. This point is one well worth notice by central station managers similarly situated.

A Much-Traveled Cat.—According to a contemporary, an ambitious cat recently sprang into the fly-wheel of a large engine in a refrigerating company's power plant, and as the engineer could not shut down, the animal was compelled to stay in the fly-wheel for two hours and a half. When the engine was finally stopped, the cat was found alive, having traveled about 73 miles in a circle. It is not stated what sort of geometrical figures the cat described upon attempting to walk after being released from its peculiar imprisonment; it is safe to assume, however, that that cat's appetite for pi is permanently satisfied.

Underwriters' National Association.—At the the annual meeting of this Association held in New York on Dec. 11 and 12, some important decisions were reached regarding changes to be made in the National Code for 1901. A motion to change the limit of low-tension circuits from 300 to 550 volts was carried at the first session. During this session, also, a long discussion took place on the advisability of grounding one of the wires in low-tension circuits, in which numerous authorities were quoted; and prominent electrical engineers spoke in its favor. The resolution was finally adopted to allow the grounding of one wire in every low-potential circuit, but making it optional with the installing engineer.

The committee on slow-burning insulation reported on a new style of insulated wire, and recommended its optional use for a year with the present form. The new style reverses the positions of the slow-burning and weather-proof layers. One layer of the latter is placed next to the copper and two layers of the braid containing the approved slow-burning compound surrounds it. The resolution offered to make both of these wires comply with the requirements was passed. Much work was reported by the committee on the carrying capacity of aluminum wire, and the results of a long series of tests show that insulated aluminum wire has a safe carrying capacity 84 per cent that of similarly insulated copper wire of the same size, while bare aluminum wire has only 77 per cent the capacity of the corresponding size in bare copper. These figures will be incorporated in the new code.

Prof. Puffer, chairman of the sub-committee on "The Carrying Capacity of Aluminum Wire," submitted a table, given herewith, showing the relative safe currents for aluminum and copper wires of various sizes, both covered and bare. The figures for aluminum were calculated graphically from the results of a great number of tests made on different sizes of aluminum wire, the part of the table referring to copper being taken from that already published in the code. Considering the present impracticability of using aluminum wire for interior work, however, and the fact that the figures showed a percentage relation, it was decided to merely state this percentage. A note to the present table for copper wire will, therefore, be added, to the effect that covered aluminum wire has 84 per cent the carrying capacity of covered copper wire and bare aluminum 77 per cent of bare copper. It will be noticed from the column headed "Smoking Copper" that copper wire becomes hot enough to smoke when carrying about three times its safe current. Prof. Puffer also made a report on automatic rheostats in which he pointed out large room for improvement and advocated the adoption of severer tests by the manufacturers.

	Rubber covered.			W'therp'f.		Bare.
Size.	Copper.	Aluminum.	Smok'g Copper.	Copper.	Aluminum.	Aluminum.
2,000,000	1050	880	3340	1670	1400	1290
1,900,000	1010	850	3220	1610	1350	1240
1,800,000	970	815	3100	1550	1300	1190
1,700,000	930	780	2980	1490	1250	1150
1,600,000	890	745	2860	1430	1200	1100
1,500,000	850	715	2720	1360	1140	1050
1,400,000	810	680	2560	1290	1080	1000
1,300,000	770	640	2440	1220	1020	940
1,200,000	730	610	2300	1150	970	890
1,100,000	690	580	2160	1080	910	830
1,000,000	650	550	2000	1000	840	770
900,000	600	500	1840	920	770	710
800,000	550	460	1680	840	700	645
700,000	500	425	1520	760	640	585
600,000	450	378	1360	680	570	525
500,000	390	328	1180	590	500	455
400,000	330	275	1000	500	420	385
300,000	270	226	800	400	340	310
200,000	200	168	600	300	250	230
0000 B&S	210	176	605	312	264	233
000	177	149	515	262	220	200
00	150	126	440	220	185	168
0	127	107	380	185	155	141
1	107	90	325	156	131	119
2	90	76	285	131	110	100
3	76	64	245	110	94	85
4	65	55	210	92	79	72
5	54	45	180	77	65	59
6	46	39	155	65	54	49
8	33	28	118	46	38	35
10	24	20	85	32	27	25
12	17	14	65	23	19	18
14	12	10	48	16	13	12

A great number of break-down and short-circuit tests have been made on fuses during the year and many exhibits were made of fuse blocks that had been rendered unsafe by the blowing of the fuses. The mica-covered cut-out was strongly condemned as a fire hazard. The difficulties in getting a fuse block which could not be improperly fused were discussed, and it was the general opinion of the speakers that some form of enclosed fuse was the nearest approach to the solution of this problem. For small currents, some form of plug cut-out, similar to the familiar lamp socket fuse plugs of the General Electric Company, were recommended. The spacing of break distances in switches and fuse blocks gave rise to some discussion. As they stand in the code at present the required distances for fuses is considerably less than for switches. After quite a little discussion, they were allowed to stand as now printed.

ESTABLISHED 1889.

American Electrician,

WITH WHICH IS INCORPORATED
Electrical Industries.

CECIL P. POOLE, Editor.

Published on the first of each month by the
American Electrician Company,
NEW YORK: 120 Liberty Street.
CHICAGO: Monadnock Block.
PHILADELPHIA: 929 Chestnut Street.

JAMES H. MCGRAW, President.
A. E. CLIFFORD, Vice-President.
C. E. WHITTLESEY, Treasurer.
E. E. WOOD, Secretary.

Subscription, - $1.00 Per Year.
In the United States, Canada and Mexico.
FOREIGN COUNTRIES, $2.00.

NOTICE TO ADVERTISERS.

Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

IMPORTANT NOTICE.

Intending subscribers are warned not to place subscription orders with persons who cannot show written authority to take such subscriptions and make collections therefor, as the paper will not undertake to fill orders placed with alleged agents acting without such written authority.

Subscribers requesting a change of address should invariably furnish both the old and the new address.

Vol. XIII. JANUARY, 1901. No. 1

The American Electrician has a larger paid subscription list than any other electrical journal in the world.

CONTENTS.

A Representative American Central Station ... 1
Recent Types of British Central Stations. 9
A Typical European Engine Governor...... 13
Electricity in the Nineteenth and Twentieth Centuries, by A. E. Kennelly, Sc. D. 14
A Century of Progress in Steam Engineering, by A. F. Nagle, M. E. ... 17
The Independent Telephone Exchange at Atlanta, by E. E. Clement ... 19
Annual Meeting of the Engine Builders' Association ... 23
Abstracts from Foreign Contemporaries... 24
Some Recent Electrical Patents ... 27
New Books ... 28
Notes ... 28
Editorial ... 30
Design for a 75-Light Dynamo, by Cecil P. Poole ... 32
Points on Insulation Testing, by Fred P. Woodbury ... 34
A Simple Railway Signal System, by E. C. Parham ... 34
Interior Telephone Systems, by W. S. Henry ... 36
Starting and Stopping Direct-Current Dynamos Operated in Parallel, by Alton D. Adams ... 37
The Sprague Multiple Unit Railway System, by Edward Chilton ... 39
Steam Injectors for Boiler Feeding ... 41
Lessons in Practical Electricity ... 44
Letters on Practical Subjects ... 46
Electrical Catechism ... 48
Queries and Answers ... 49
An Incandescent Lamp Comparimeter...... 50
C & C Series-Parallel Controller System... 50
The Modern Gas Engine ... 51
Automatic Machine for Plating Electric Light Carbons ... 51
New Apparatus and Appliances ... 52
The Business Situation at the Close of 1900. 57
Obituary ... Adv. 57
Legal Note ... Adv. 57
Personal ... Adv. 57
Trade Publications ... Adv. 58
Business News ... Adv. 59

The New Year.

When a large number of widely separated persons independently render almost precisely identical opinions on any particular subject it is entirely legitimate to conclude that the opinions are well founded. Hence, one may feel justified by the remarkable coincidence of expressions published elsewhere in this number in expecting that the year just born will be a most progressive and prosperous one for the electrical and allied industries. It is little short of astonishing to note how very slight is the deviation from unanimity of opinion as to the prospects for the coming year, with less than half a dozen exceptions, the letters which are abstracted on pages 57 to 60 reflect a most sanguine feeling regarding the business outlook. We cordially congratulate all concerned upon the optimistic state of affairs and trust that everybody's "great expectations," unlike those of poor Pip, may be fully realized.

Impending Developments.

The extremely interesting and instructive discussions in this number of electrical and steam engineering in the two centuries which have just met leaves little to be said. There have seldom, if ever, been published any synopses of the development and status of the two great branches of applied physics so comprehensive as these, and no student should fail to read both articles carefully.

Predictions are always rash and seldom fulfilled; besides, the practical man, for whom this paper is published, is much too busily occupied with solving the everyday problems of the present to clutter his mind with hypothetical and more or less visionary deductions, but a brief consideration of impending progress may not be uninteresting or supererogatory. Of the several recent developments in applied science which are not yet matured, the Nernst lamp and Marconi telegraphic system appear the most promising, so far as the immediate future is concerned. It is impossible to hazard an opinion as to the ultimate future of the Nernst lamp; such an attempt would be reduced to the worthless level of a mere guess. It seems reasonable, however, in view of the steady progress that is being made in Germany, to expect that the Nernst lamp will soon become a most important factor in lighting practice. It is not visionary to suppose that the glower will eventually be made sufficiently substantial to put the operation of the lamp on a basis commercially practical in every sense of that term. The lamp being electrolytic in action, it is not well suited for direct-current service; consequently, it will constitute a powerful ally for alternating-current enthusiasts, and it is not unlikely that its perfection will mean the abandonment of arc lighting for ordinary purposes. Wherever direct-current service is considered preferable, however, the arc will doubtless remain supreme.

The Marconi system of telegraphy, or some progeny of it, may ultimately render worthless the existing land and submarine lines, but nothing thus far developed indicates that this stage of perfection is imminent. That the system has an important field is perfectly obvious; but while the limitations of its scope cannot be described now with the slightest degree of certainty, it seems evident and rational that there are and always will be such limitations and that the abolition of metallic conductors is a very hazy contingency. And the application of the Hertzian principle to telephony is still more indefinite; the delicacy of telephonic apparatus is such that its reliable operation by non-directive ether waves or stresses or whatever one may term them would not seem to be ordinarily practicable.

In "heavier" electrical engineering the alternating-current motor represents the most recent advance and about the only mechanism having extensive possibilities of development. What is needed in order to round out the alternating-current system is a motor that will start efficiently under load from standstill, run efficiently at various speeds and be devoid of a fractional power factor. The production of such a machine will be a tremendous achievement, but greater things have been done before.

American and English Central Stations.

At the present rate of approach toward common ground it will be only a comparatively short time before a comparison of American and English central station practice will fail to reveal any divergence beyond unimportant details. Many of the rigid lines of demarcation which formerly separated the ideas of the engineers of the two countries have been considerably softened and not a few of them have been entirely obliterated. It requires but a small effort of memory to recall the day when the Edison type of direct-current dynamo, so magnificently developed by the Hopkinsons, was the almost exclusive central station standard in England. To-day, a considerable number of bipolar machines are in use, but the allegiance of British engineers is being steadily transferred to the multipolar type which has for several years ruled here; a type, it is only fair to state, that is not American in origin, although it is so in point of highest development. Alternating-currents are slowly but surely gaining ground also in England, as are enclosed-arc lamps. On the other hand, comparatively high potential three-wire distribution (220—250 volts on each side) which has been in use across the Atlantic—well, it may be more considerate to omit dates—has begun to make a discernible impression in this country. The gradual convergence of the two lines of practice is noticeable also in many incidental features which it is unnecessary to enumerate.

In steam work there are not such well-defined indications of destined conformity. The English central station almost universally employs vertical high-speed engines, usually provided with throttling governors, whereas horizontal engines of moderate speed are used in a large majority of American plants and regulation by varying the point of cut-off is the invariable practice. Mr. Ferranti, whose progressive ideas and sound practice make him a colossal figure among designers of both steam and electrical machinery, has made use of variable expansion for engine regulation, but his engines are notable exceptions to British practice. The differences between English and American engines seem rather unaccountable in view of the similarities between the practice in Continental Europe and that in the United States.

Inductance and Reactance.

These two terms, judging from the letters which are received at this office (and cheerfully answered), seem to be greatly confused in the minds of many students; and when one considers the changes that have been made in electrical terminology during the past few years this is not very surprising. However, if the beginner will commit to memory the fundamental fact that inductance is a cause and reactance an effect, it will be easier to distinguish between the two terms. A coil or a loop of wire is possessed of the property of inductance, whether current be passing through it or not. The extent of this property depends upon the number of turns of wire in the coil, and the magnetic conductivity of the medium which is encircled by the coil. A coil of 50 turns, for example, wound about a soft-iron core, has very much greater inductance than a coil of the same number of turns without any iron core; and a coil of 10 turns on a core has much less inductance than one of 50 turns on the same kind of core.

Reactance, on the other hand, is the direct result of inductance, without which it could not exist. The reactance of any electrical circuit is the product of its inductance, the number of times the current flow is reversed per second, and a constant. The measure of inductance is the henry, and its symbol is usually the letter "L." The measure of reactance is the ohm, like that of resistance, and it is usually represented by the letter "X," but a coil has no reactance until a current passes through it and the rate of flow is varied. Representing the number of complete reversals per second of an alternating current by the letter "N," the formula for reactance is: $6.28 \times N \times L = X$, and this shows more plainly than any lengthy explanation could do the direct relation between inductance, L, and reactance, X.

Another term which contributes to the confusion of a beginner is reactive e.m.f. The value of this is obtained by multiplying the reactance, which is expressed in ohms, by the current flowing in the circuit, just as one obtains the drop in a direct-current circuit by multiplying the resistance by the current. The reactive e.m.f. is induced by the magnetic lines of force which are created in the coil by the passage of current through it; these lines are "cut" by the wires of the coil exactly as the line of force passing from the field magnet of a dynamo to its armature are "cut" by the conductors on the armature core. This phenomenon was formerly termed self-induction, but the term has been practically abandoned, notwithstanding its excellent explanatory character.

Electric Railway Car Control.

A recent court decision awarding $4000 damages to a woman for injuries caused by a fall due to a sudden spurt by the car on which the complainant was a passenger naturally tends to impress upon thinking persons the fact that there is room for improvement in the present method of controlling such cars. It is scarcely necessary to point out that the corybantic evolutions which a motorman devoid of delicate sensibilities may (and usually does) compel standing passengers to perform are not irremediable accompaniments of the present system of railway car control. It is, of course, entirely a matter of volition on the part of the motorman whether he shall accelerate his car gradually and allow "strap-hangers" a fighting chance to reach home intact, or whether his manipulation of the controller and brake handles be such as to impart to the car the traveling characteristics of a kangaroo and to enforce acrobatic transpositions upon unfortunates who have to stand. If the patrons of a railway line were all centipedes, or had even an extra pair of legs each so that they might stand in quadrature, so to speak, jamming the controller handle from zero to the fifth notch with a single graceful sweep might be innocuous pastime; under existing anthropological conditions, however, only an unusually agile monkey or jack-rabbit is entirely safe in a car driven by a careless motorman.

As noted above, the present system of car control does not necessarily entail the abrupt jerks and disconcerting stops which one constantly sees practised. It renders them possible, however, and a great improvement would be wrought if the traction companies could be made to realize the importance and practicability of removing the rate of acceleration and retardation from the motorman's control. There are several ways of accomplishing this which it would be superfluous to suggest to well-posted engineers. The rate of acceleration is automatically controlled now in some electric train systems, and there is at least one form of power brake available which takes care of the rate of retardation to a sufficient extent to prevent the dangerous "stone-wall" stops that appear to be one of the special joys of a certain class of motormen. The only excuse that is apparent for the retention of the clumsy hand-brake and the use of unchecked controller mechanism is the extra expense involved in providing semi-automatic in place of purely manual apparatus. Until such time as the railway companies avail themselves fully of the engineering facilities and resources at hand it might be advisable for passengers to provide their clothes with rubber linings which can be blown up to form enveloping air cushions just prior to entering a car.

DESIGN FOR A 75-LIGHT DYNAMO.

BY CECIL P. POOLE.

The accompanying sketches illustrate the salient features of a dynamo designed to maintain 75 16-c.p. incandescent lamps at 110-120 volts. The field magnet is of the familiar radial-pole type with circular yoke, and is provided with a partial "shrouding" on each side somewhat similar to the practice observed by the Crocker-Wheeler Company. The principal object of this shrouding is to give the machine a rather more finished appearance than it would have without it, and if any reader who may undertake to build the dynamo prefers to leave off this web it may be done without affecting the operation of the machine.

Fig. 1 is an end view of the field-magnet frame minus the coils and journal boxes. Fig. 2 is a plan view of the frame, which shows the arrangement of the projecting feet that support the journal pedestals, and Fig. 3 is a sectional view on a line through the center of the field-magnet structure. In order that the design may be available to a larger number of readers, cast iron has been adopted as the material for the field magnet instead of cast steel, which, of course, is the usual modern practice. The only machine work necessary on the field magnet is boring out the pole faces and tooling the seats for the journal pedestals, all of which must be done at one mounting of the magnet frame in order to insure accurate alignment between the armature chamber and the journals. Fig. 4 is a section of one magnet pole and the corresponding part of the yoke, taken on the line C-D of Fig. 1, and Fig. 5 is a cross-section of a magnet core taken on the line A-B in Fig. 3.

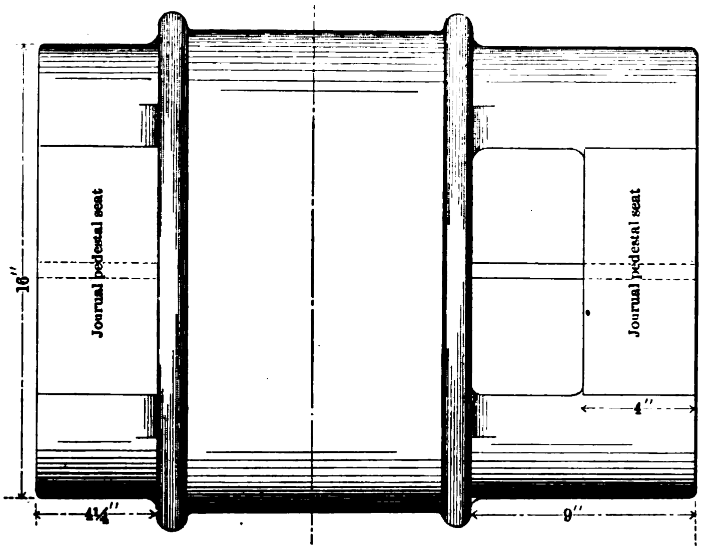


FIG. 2.—PLAN VIEW OF MAGNET FRAME.

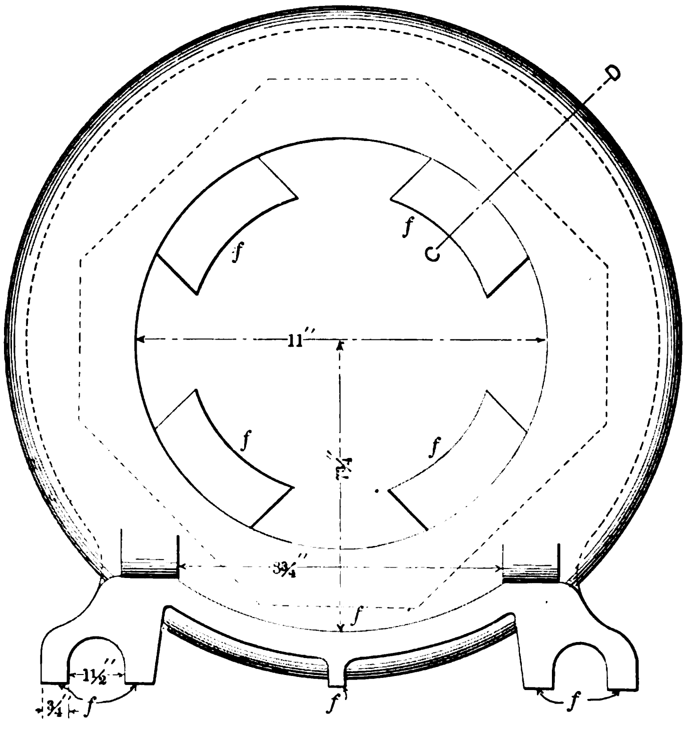


FIG. 1.—END VIEW OF FIELD MAGNET.

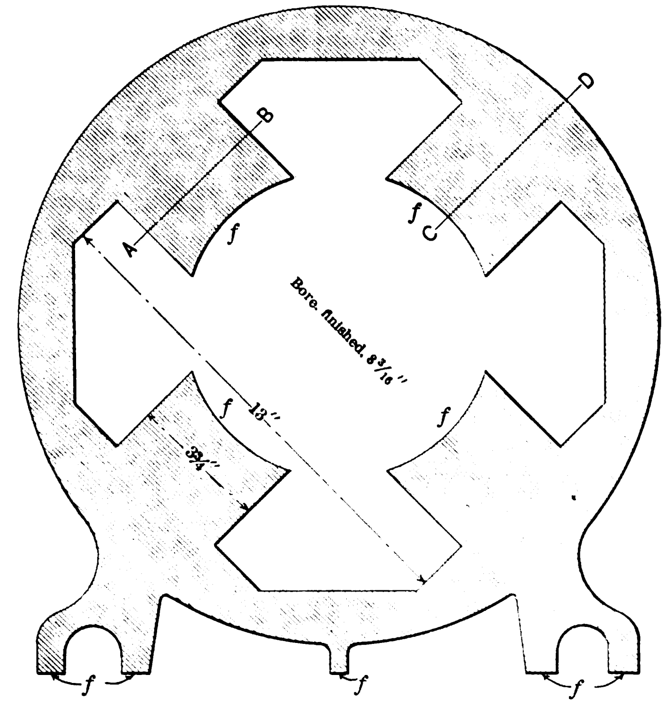


FIG. 3.—TRANVERSE SECTION OF FIELD MAGNET.

The dimensions of the magnet, which are not shown in the drawings, are as follows:

	Ins.
Extreme diameter of shell	17
Extreme diameter over the ribs	18¼
Distance between ribs	9
Thickness of each rib parallel with shaft	1
Total plan length of field-magnet frame from outside to outside of journal pedestal seats	24½

Figs. 6 and 7 are sectional views of a journal box and pedestal, the former being an axial section and the latter a transverse section. The section of Fig. 6 is taken on the line J-K of Fig. 7, and the section of Fig. 7 is taken on the line H-I of Fig. 6. As the sketches plainly show, the bearing is of the oil-ring variety, with a circular reservoir, and the sleeve is perfectly straight, this type being much easier for an amateur to construct than a self-aligning bearing. If ordinary care is taken in cutting the seats of these pedestals and in turning off their bases, the bearings cannot fail to come in alignment without any special provision in the way of a swiveling bushing. The pedestals and journal boxes are of cast iron, of course, and the bushing may be made either of solid brass or of a thin seamless brass tube babbitted. On the inner end of one journal box a seat ½ in. long should be turned for the brush-holder yoke. Only two sets of brushes are required, and these must bear upon the commutator exactly one-fourth of a circle apart. The brush yoke, therefore, may be of the V type in preference to the ordinary straight arm which is used on bipolar machines. Returning to the bearings, the oil rings will be 2½ ins. in diameter, inside, 5/16 in. wide parallel with the shaft, and ⅛ in. thick, measured radially.

Fig. 8 shows the shaft and a sectional view of the armature core and supporting drum. This drum is a simple cylinder, *d*, 8 ins. in diameter outside when finished, and provided with a flange, *g*, at one end, which carries at its outer edge a drum or barrel, *b*. The function of this barrel is to support the projecting ends of the armature coils. The discs are mounted on the drum, *d*, and clamped in place by means of a ring, *r*, which carries a barrel, *b*, exactly like the one on the flange of the core drum. These flanges project 2¼ ins. from the core discs. The ring, *r*, may be secured to the drum, *d*, by means of six 3/16-in. machine screws. The dimensions of the different parts of the shaft are marked on the sketch, as well as the principal dimensions of the armature core and spider; those which are not indicated are as follows:

	Ins.
Diameter of extension barrels.........	5¾
Diameter of core hubs, h..............	2
Extreme length of core drum from end to end of the hubs................	9¼
Diameter of core drums, d............	3
Radial thickness of drum wall........	⅜
Thickness of flange, g, and ring, r, parallel with shaft..................	½
Diameter of armature discs...........	8
Number of slots........................	40
Size of each slot.........................	¼ x 1.3

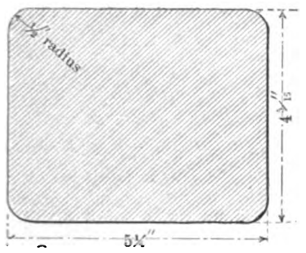


FIG. 4.—CROSS SECTION OF MAGNET POLE.

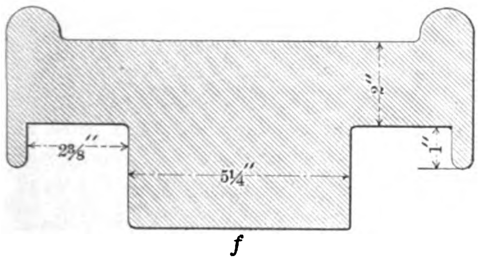


FIG. 5.—RADIAL SECTION THROUGH MAGNET POLE AND YOKE RING.

The commutator should be purchased from some of the standard manufacturers. Its extreme length along the shaft must not be over 4¼ ins. It must have 41 segments, and should be not less than 5 ins. in diameter. The width of the brush tread parallel with the shaft must be not less than 3 ins., and the diameter from tip to tip of diametrically-opposite connecting lugs must be 7½ ins.

The machine is designed for the use of carbon brushes, each set comprising two brushes ⅝ x 1¼ ins. The builder can exercise his own judgment as to the type of brush-holder to be used, but should remember that it is indispensable to have a reliable contact of low resistance between the brush and the holder. As noted above, there are only two sets of brushes, these being set "on the quarter," or 90° apart.

The field winding of the machine consists of four coils of No. 18 double cotton-covered magnet wire wound 14 layers deep and 46 turns long parallel with the axis of the core, giving 644 turns per coil. If the builder is able to put more turns than this without exceeding a depth of 11/16 in., so much the better, but the coil should not be deeper than this. The coils are connected up in the usual manner, so that the polarity of the magnet cores alternates, and a rheostat must be provided to regulate the field current. As in the case of the commutator, it is wholly inadvisable for an amateur to attempt the construction of his rheostat; consequently, no directions are given for this.

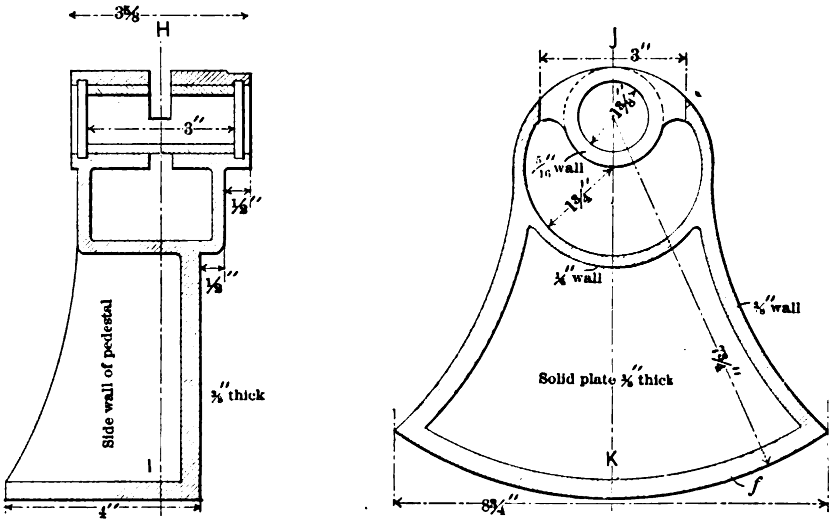


FIG. 6.—SECTIONAL VIEWS OF JOURNAL BOX AND PEDESTAL.—FIG. 7.

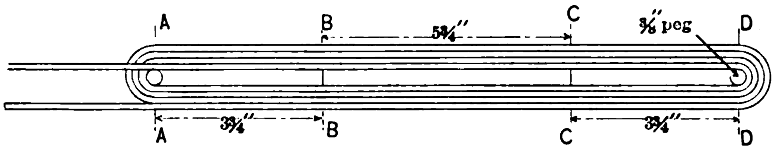


FIG. 9.—ARMATURE COIL BEFORE SHAPING.

Each field coil must be taped with two layers of German-linen tape wound through the coil shuttle-fashion, so that the tape crosses the wires at right angles. As in the case of the armature coils, each layer of taping must be wound with a half lap, varnished and thoroughly dried, i. e., the first layer must be thoroughly dried before the second layer of tape is put on, and then the second layer must be varnished and dried similarly.

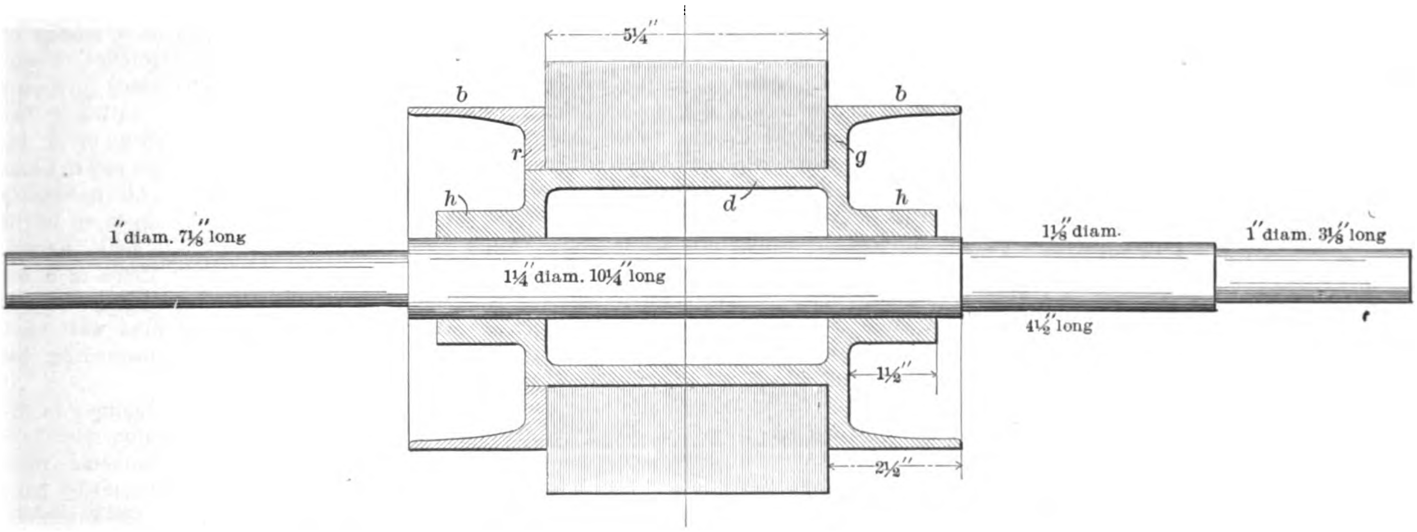


FIG. 8.—ARMATURE SHAFT AND AXIAL SECTION THROUGH ARMATURE CORE.

The armature winding consists of 41 coils of No. 8 double cotton-covered magnet wire, each coil containing 4 turns. The coils must be wound around two ⅜-in.

pegs, as indicated in Fig. 9, the four turns being wound one on top of the other, so that when the coil is finished it will present about the appearance shown in the sketch. The convolutions of the coils should be secured with fine linen thread at each of the bends; also at the two points indicated by the lines, B, C. Then the ends of the coil should be clamped from the points, A and B, outward, and the two sides pulled in opposite directions until the plan of the coil assumes the shape shown in Fig. 10. Then it should be carefully wrapped with two layers of German linen tape, each layer being wound with a half lap so that there will be two thicknesses of tape in each layer of four thicknesses altogether. Varnish each layer and bake the coil until it is thoroughly dry.

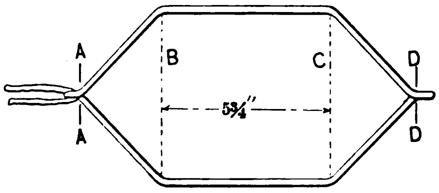


FIG. 10.—ARMATURE COIL, SHAPED.

The coils must be assembled on the armature core so that between the two sides of each coil there will be 10 teeth. It is absolutely imperative that all of the coils be wound exactly alike so that the starting ends of all of them will occupy exactly the same position at the bend of the coils. When the coils are all in place on the core they should be secured temporarily by two retaining bands of twine wrapped around the core at each end. Then the terminals should be carried to the commutator, all of the lower terminals being put in place first.

It will be found advantageous to lead the lower terminals to the left about 10 commutator bars instead of carrying them straight out to the nearest bar. Having put the lower ends in place in rotation, start at any convenient place with the upper ends, carrying the first one around to the right and inserting it in the commutator segment which is 20 spaces from the segment containing the under end of the same coil. In other words, between the two segments to which the terminals of any coil are connected there must be 19 other segments. This is illustrated by Fig. 11, which shows the terminals of one coil connected to the commutator. After the ends have been soldered in, a binding of No. 18 tinned-iron wire should be put around the center of the core, and another binding of either strong cord or thin brass wire should be put around the projecting ends of the coils near the ends of the supporting barrels. All of the binding wires must be wound on fiber strips not less than 1/64 in. thick.

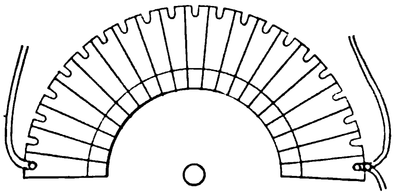


FIG. 11 —TERMINALS OF ONE COIL IN PLACE.

The principal data applying to the machine are as follows:

Armature speed	1500 r.p.m.
Normal armature current	43½ amperes
Drop in armature winding	4 volts
Normal exciting current in field winding	3¼ amperes
Magnetic density in field magnet cores	47,000
Magnetic density in air gap	36,000
Magnetic density in armature teeth	109,000
Magnetic density in armature core	70,000

POINTS ON INSULATION TESTING.

BY FRED P. WOODBURY.

There are two methods of testing the insulation of electrical machines commonly in vogue. The first is simply a measurement of its resistance and, like all such measurements, may be accomplished either with the bridge or by the voltmeter method. Such a measurement of resistance is of value in determining the general condition of insulation, but it may not show a weak spot of small area. It is an excellent method for determining if there is dampness in insulation that is otherwise good.

The second method of testing is to subject the insulation to a high potential. This is a sure test, but must be carefully and properly done, or serious injury to the insulation may result. It should always be borne in mind in testing insulation of apparatus that the object in view is not to determine the extreme limit of pressure it will withstand, but to ascertain if it is strong enough to withstand continuously the maximum voltage to which it is likely to be subjected, and be as nearly puncture proof as possible against any static charge that may seek a ground through its medium.

Voltage subjects insulation to a mechanical strain just as truly as does steam within a boiler tend to force it open. The folly of testing a boiler until the plates begin to shear will be apparent to anyone. For the same reason it is unwise to subject insulation to a pressure beyond its limit of elasticity. A case illustrating this point which came under the writer's observation was that of a purchaser of some 10,000-volt transformers who stipulated that the manufacturer should test the insulation with 45,000 volts (between the primary winding and the iron) for fifteen minutes continuously, while hot. The transformer stood the test, though the leakage increased greatly as it progressed, thus permanently weakening the insulation. A far more rigid and less injurious test would have been to apply 55,000 volts for two or three seconds.

It is evident from the foregoing that while the test should be severe enough to give an ample margin of safety above the working voltage, it should not approach very near to the probable break-down point of the insulation. In testing with alternating current the potential should be applied gradually. It is well to place the high-potential leads of the testing transformer in position first; then close the circuit in the low-tension primary with resistance in series, which should be cut out until the desired voltage is obtained between the high-tension leads. The resistance should be cut in again before the circuit is opened. It is desirable to have the primary circuit lightly fused. The highest voltage should not remain on for more than three or four seconds. In using direct current for testing, enough resistance should be put in series to prevent an abnormal flow of current in case the insulation should break down.

The tests should always be made when the insulation is hot, as it is then more likely to show any weakness.

The necessary strength of insulation varies more with the class of work the machine must perform than with the working voltage. Thus, for example, a 500-volt street-railway motor should stand a test of at least 3,500 volts (alternating current) between the frame and winding, while if a railway generator will stand 2,000 volts it is sufficiently well insulated. Stationary motors or generators of 200 volts or less should stand 1,000 volts, and 600-volt machines should have a test of 1800 or 2000 volts.

Alternating-current generators of 1000 volts should be tested with 5000 volts, and machines of 2000 volts output should stand 8000 volts. Transformers of 1000 volts primary voltage should be tested with 6000 volts between coils, and also between primary and iron; 4000 volts is an ample test between the low-tension secondary and the iron.

The insulation tests of large high-tension power-transmission transformers vary greatly, sometimes reaching 120,000 volts. Care should always be exercised to see that the insulation to be tested is normally dry; a good machine may be needlessly injured just for the want of a little "drying out."

A SIMPLE RAILWAY SIGNAL SYSTEM.

BY E. C. PARHAM.

Signal systems are, as a rule, used on single-track trolley roads as a means of blocking cars out of the stretches of single track in between switches or turn-outs as they are more commonly called. The signal is generally in the form of an incandescent lamp, which shows red to block a car; and white, or not at all, to signify that the track is clear. If the lamp in the signal box at the approach to a single track shows red, it means that there is a car somewhere on that stretch of track and that all approaching cars must wait until the line is clear before proceeding beyond the signal.

Some signal systems are manual in operation and others are automatic. On manual systems, every conductor must leave his car and throw the signal by hand if it is to be thrown at all. On automatic systems, the signals are operated by some interference on the car itself or on the track, or by insulated sections in the trolley wire or rail. Nearly all such systems involve the use of electromagnets to operate switches or throw targets. Lightning seems to take a fiendish delight in playing destructively with these magnets, so that automatic signal systems employing electromagnets are not very generally adopted.

There are several conditions that every signal system should fulfill; it must be simple, cheap, reliable, of substantial construction, and well protected from thieves and the weather. Up to the present time the best systems are compromises between these several conditions. The one that most successfully meets all conditions is the "telephone dispatch" system, in which there is a telephone in a locked box at every turnout. These telephones connect with a central office presided over by a regular train dispatcher, who pegs the cars and sends out his orders the same as on a steam road. Every conductor upon arriving at a switch, rings up central, reports his train number and gets his orders. The telephone dispatch system is not cheap enough for some roads and is not necessary on others where the train speeds are low.

There is no system so much used nor is there any that gives more general satisfaction than a simple arrangement of incandescent lamps that can be installed by any line-man. Fig. 1 is a diagram of the connections for an 8-lamp signal system, and Fig. 2 shows the actual arrangement of the lamps. In Fig. 1, K1 and K2 are two simple three-way tongue switches, such as can be quickly and cheaply made in any machine shop. One of these switches is placed at each end of the stretch of single track to be protected and the two switch tongues are connected by means of a wire (this can be a No. 10 or No. 12 iron wire) strung on the line poles, and including two red lamps, Ra, Ra. Each switch has a trolley contact, 2, and a ground contact, 3, each wire leading up to the trolley wire has two lamps in series with it, marked Wa and Wb, and each ground wire one lamp, marked Rb, Rc. Each switch then is connected to two red lamps and two white ones.

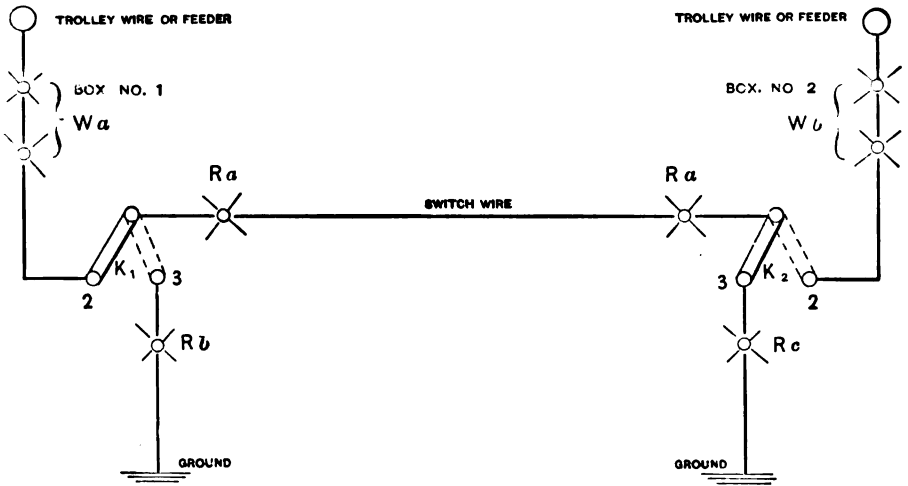


FIG. 1.—DIAGRAM OF CIRCUIT FOR ONE BLOCK.

When the two switch tongues are in the full line position, the two white lamps Wa, and the red lamp, Ra, light in the No 1 signal box, at, say, the west end of the single track; and only the two red lamps, Ra and Rc, in the No. 2 box at the east end. If the two switch tongues are in the dotted position, the lamps get current from the No. 2 trolley connection and the two white lamps, Wb, and the red lamp, Ra, light in the No. 2 box, while the two red ones in the No. 1 box light. If both of the switch tongues are thrown onto the No 2 buttons, both ground lamps are cut out and all of the other lamps being connected only to the trolley, are also left dark. Also, if both tongues are thrown to the No. 3 blocks on their respective switches, none of the lamps can light.

Fig. 2 shows a form of signal box. It has two parts, an open part for the white lamps and a closed part for the red ones. The white lamps are on top and outside, but are protected by a hood and cages (the latter not shown); the lamp-sockets are of the protected weather-proof type. In the door and two sides of the box are set panes of glass; if the glass is red, the lamp globes are all ordinary white ones. The signal box is kept locked and every inspector has a key. Inside of each box two extra lamp globes are kept. The trolley and ground blocks of the three-way switches should be at least 7 ins. apart to avoid short-circuits; the lamp in the ground wire lessens the chances of such a mishap. The closed part of the box need have no lining save a coat of thick shellac, such as comes out of the bottom of a shellac pot. The switch handle protrudes through a slot in the bottom of the box; this handle must always be at the extreme right or left when the system is in service; never in an intermediate position.

The only likely source of trouble in such a box is due to open circuits caused by loose connections, broken wires or broken lamp filaments. To minimize the chances of any such troubles, all connecting wires should be of flexible cord and all connections soldered. With these precautions the system can be made almost absolutely reliable, if instead of one lamp two lamps in multiple be used in each case and the ground, trolley and signal wires all be run two in parallel, or made of flexible wire. Such a signal box gives much better satisfaction if, instead of being hung on one of the regular line poles where it is subjected to all of the jarring and vibrations that the line suffers, it is clamped to a short post of its own. The connections should be inspected after each storm. The inside of the box should be kept clean and the handle should not be allowed to get loose so that it may be released by jarring

The system is operated as follows: Say that a conductor approaching the No. 1 signal box finds all lights are out; this means that the tongues of both switches are on the same blocks of their respective boxes. It further means that if the lights are in good working order and are, therefore, not out on account of a fault, some car passing out of the block has extinguished them and the line is therefore clear. The conductor, before allowing his car to proceed, throws the switch to the opposite position from that in which he finds it. If it rests on the No. 2 or left-hand side of the box the tongue at the far end of the block also rests on the No 2 side of the signal box there, or the lights would burn. By throwing the tongue to the No. 3 side of the No. 1 box, that box will show two red lights, Ra and Rb, and the No. 2 box will show one red light, Ra and two white ones, Wb.

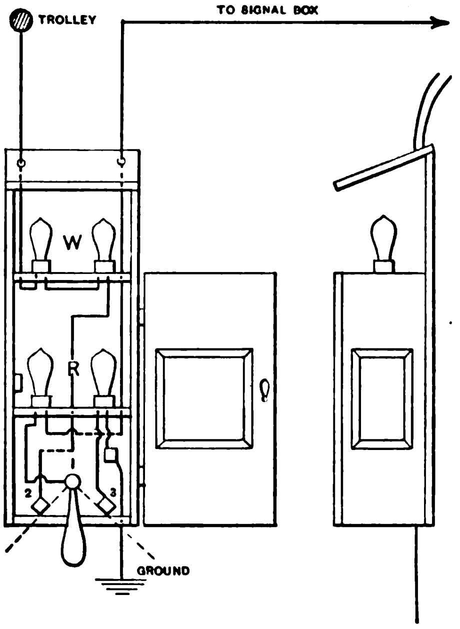


FIG. 2.—A SIGNAL BOX.

No matter what may be the positions of the two switch tongues, if the lights are out, throwing either of them to the opposite side will light a red lamp in both boxes and block the road in between those two boxes and no second car is supposed to enter the block until the signal lights are out. On passing out of the block the conductor opens the block behind him by throwing the No. 2 switch tongue to the opposite side, thereby putting out the lights on the block he has just run through. The next stretch of single track constitutes a second block; it is protected by two more signal boxes which must be operated in the same way.

It is very amusing sometimes when two cars approach an open block from opposite ends at the same time, to see a conductor rush over to the box and get the red light against him just as he is going to give it to the other fellow.

INTERIOR TELEPHONE SYSTEMS.

BY W. S. HENRY.

SMALL SWITCHBOARD SYSTEMS.

When the number of telephone stations exceeds about twenty, depending more or less upon the frequency with which the telephones are used, it is not a very good plan to use an intercommunicating system. It is better to connect each telephone directly with a centrally-located switchboard, at which an operator is usually required to make the necessary connections between the various stations or "subscribers," as it will be convenient to call them. Automatic switchboards requiring no operator may be had, but up to the present time they do not seem to have made much headway, probably owing to their complicated mechanism and greater liability to get out of order than the manually-operated switchboards.

For a small system not exceeding fifty or seventy-five stations, and especially when there is no experienced electrician to look after it, the switchboard should be made as simple and durable as possible. For this reason it does not seem advisable to use complicated combination listening-and-ringing keys, nor self-restoring drops. The boy or girl who generally attends to such a board, sometimes, in addition to other duties around the office or factory, usually has plenty of time to make the necessary connections.

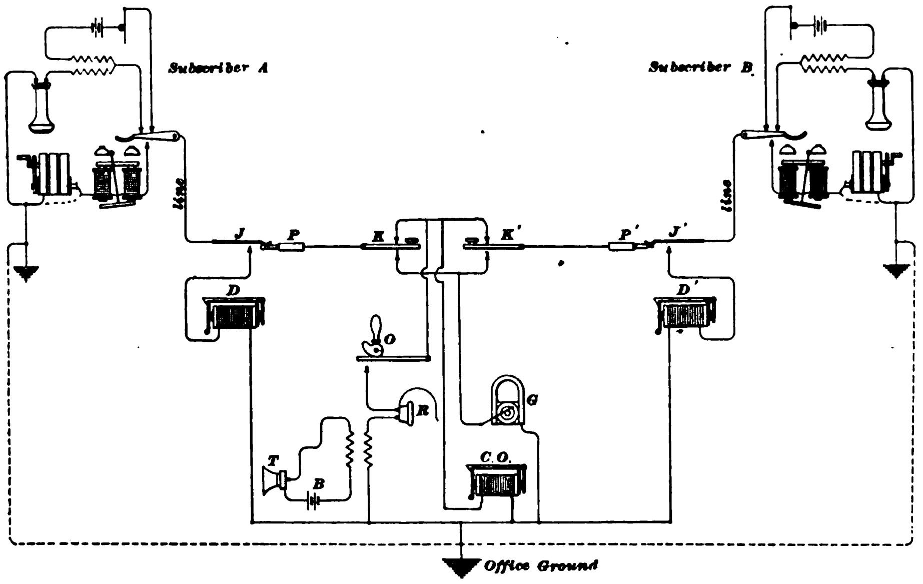


FIG. 1.—DIAGRAM OF SIMPLE SWITCHBOARD SYSTEM.

While common-battery or central-energy systems would seem to be the ideal plan for an office or factory where the distances are short, still, unless very well designed and cared for, such a system does not always give as good service as it should. Separate batteries at each station, merely for operating the transmitters, have some advantages. Such an arrangement, with automatic signalling, whereby the central office can be called up by simply removing a subscriber's receiver from the hook-switch, seems in the present state of affairs—considering the fact that the Bell Company probably owns the most desirable patents on common-battery systems—to be about the best, and since it has proved satisfactory for large town exchanges, it should certainly be satisfactory for factories and office buildings.

Although the writer hesitates to recommend dry cells for use at the subscribers' stations, nevertheless they are now being used successfully by a few companies. They have the advantages of being very cheap and requiring no care, which is not true of wet batteries. On an average they will last about nine months in telephone service, and after that they are still good for a year or more in ordinary bell circuits where they are only in use for a few seconds at a time. A dry cell should never be used in a telephone circuit after it falls below three-fifths of a volt, for it will no longer hold out for long conversations. It is a waste of time and money to attempt to recharge dry cells; they can be bought for twenty cents or less apiece; in very large lots they have been bought as low as fourteen cents. Disregarding first cost, a good wet cell is much preferable to any dry cell.

All new switchboards, no matter how small, should be wired for complete metallic circuits; that is, two separate wires throughout for each telephone line. The switchboard should not be wired on a common-return plan, even if it is desirable to use the ground or one common wire as a return path from all the telephone stations. However, on account of its simplicity, a common or ground-return system will be described first, for it will enable the reader to more readily understand the succeeding descriptions of other systems.

The circuits of one of the simplest possible systems are shown in Fig. 1. In case a common-wire return is employed instead of a ground return, the connections are made as shown by the dotted lines, the ground connections at the telephone stations and at the switchboard being omitted. Two telephone stations, their connection with the spring jacks, J and J^1, as these switch devices are called; the annunciators or drops, D and D^1, and one operator's cord circuit are shown. The cord circuit consists of two plugs, P and P^1; two ringing keys, K and K^1; one listening key or cam, O; a clearing-out or call-off annunciator or drop, CO; a generator, G; a watch-case receiver, R, with head strap; a microphone transmitter, T; a microphone battery, B; an induction coil, and the necessary connecting wires. The same transmitter, T, battery, B, receiver, R, and generator, G, are used in connection with each one of the ten pairs of cord circuits that are usually provided for about each one hundred jacks on the board. It is evident that one operator who has charge of ten pairs of plug circuits would use the apparatus named on only one cord circuit at one time, and hence there is no necessity to duplicate them. One terminal of the receiver and one terminal of the generator have each ten branches, one leading to the under contact of each listening and ringing key respectively.

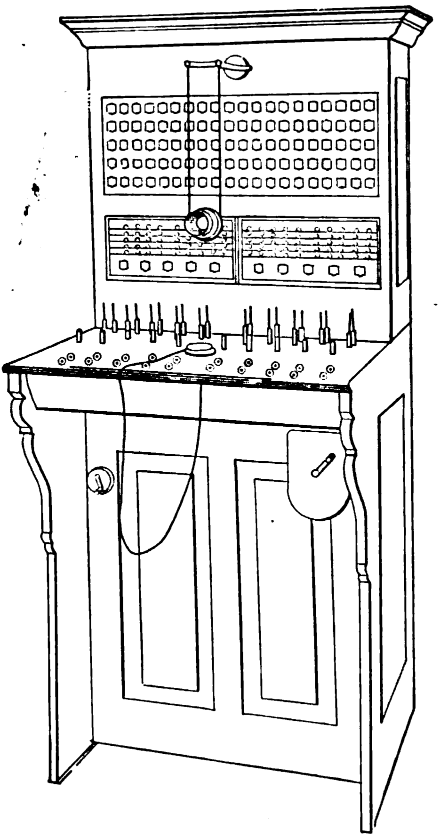


FIG. 2.—SMALL SWITCHBOARD.

The jacks, J and J^1, are usually located on the face of the board, the annunciators, D and D^1, above them, and the clearing-out drops below the jacks, each clearing-out drop being directly behind and in line with the pair of plugs with which it is associated. The plugs, when not in use, rest upright upon a projecting shelf or table in two rows, each front plug and the one directly behind it constituting a pair. As already stated, there are usually on small boards about ten pair of plugs for each hundred jacks. A switchboard with the apparatus arranged about in this manner is shown in Fig. 2. On the same shelf and in front of the plugs are the listening and ringing keys. The operator's transmitter hangs down in front of the board and the watch-case receiver is shown lying upon the shelf. Below the shelf on the right side is the hand generator. On a larger switchboard the generator should be run continuously by a motor.

On small boards it is not a bad plan to place each jack directly under the annunciator belonging to the same line, and in this case the annunciator is frequently designed and constructed so that the act of inserting the plug mechanically restores the shutter to its normal position. Such a switchboard is shown in Fig. 3. Instead of two separate ringing-key buttons, a cam is here used. Its normal position is vertical; when it is drawn forward the ringing generator is connected with the front plug; when it is pushed back beyond the vertical position, the ringing generator is connected to the rear plug or it may be arranged to ring out on only one plug, as will be explained later.

The system shown in Fig. 1 is operated in the following manner: Normally the plugs are not in the spring jacks as shown here. If subscriber A desires to converse with subscriber B, he turns the handle of his generator, thereby causing the shutter of the annunciator, D, at the central office to fall, thus notifying the switchboard operator that A wants to talk to some other subscriber. The operator inserts the plug, P, frequently called the answering plug, into the spring jack, J, that has the same number near it as that exposed behind the fallen shutter of the annunciator, D, and therefore belonging to the same line as the annunciator, D. The act of inserting the plug in the spring jack cuts the annunciator, D, out of the circuit. The operator then restores the fallen shutter by hand and pulls forward the handle of the listening cam, O. The operator and subscriber A can now communicate with each other over the following circuit: From receiver, R, through the listening key, O; the key, K; plug, P; jack, J; line; subscriber A's telephone, and back through the ground, or common-return wire, as the case may be, to the receiver, R.

The operator having asked and received the number of the subscriber with whom A desires to converse inserts the companion plug, P^1, of this pair into the proper jack, J^1. The insertion of the plug, P^1, in the jack, J^1, disconnects the annunciator, D^1, from the circuit. The operator may restore the listening cam to its normal position now or wait until later, after she has made sure that the two subscribers are properly connected by hearing them start their conversation. After inserting the plug, P^1, frequently termed the calling plug, into the jack, the operator depresses the ringing key, K^1, for a few seconds and turns the hand generator, G, at the same time. The generator current rings B's bell, passing from the generator, G, through the lower contact of the ringing key, K^1; cord and plug, P^1; jack, J^1; line; subscriber B's bell; the automatic shunt around his generator (represented by the dotted line), and back through the ground or common-return wire to the central-office generator, G. Thus subscriber B is called by the ringing of his bell.

When subscriber B, in order to answer the call, removes his receiver from the hook, the two subscribers, A and B, can communicate with each other over the following circuit: A's receiver; secondary winding of his induction coil; his hook-switch; line; jack, J; plug, P; lever and upper contact of key, K; upper contact and lever of key, K^1; plug, P^1; jack, J^1; line; B's hook-switch; secondary winding of his induction coil and receiver, and back through the ground or common-return wire to A's receiver. When the conversation is finished A and B hang up their receivers and one or both ring off—that is, turn their generator handles. Both should do so to avoid the possibility of neither doing it. This will cause enough current to flow from either subscriber's generator through the line, jack, plug, ringing key, and clearing-out drop, CO, to drop the shutter of the latter. This notifies the operator that A and B have finished their conversation and she then removes both plugs from the jacks and a weight under the table sliding on the plug cord pulls the plugs to their proper seat upon the table. The operator also restores the fallen shutter of the clearing-out drop to its normal position.

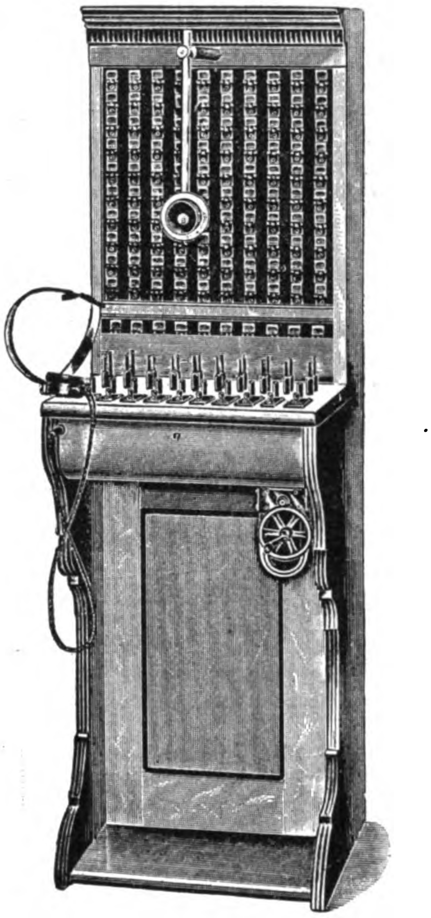


FIG. 3 —SMALL SWITCHBOARD.

It will be noticed that during a conversation the annunciators, D and D^1, are disconnected from the circuit, but that the clearing-out drop, CO, is always connected to the circuit while the conversation is taking place. The latter, therefore, forms a shunt across the talking circuit, since it is bridged from the cord circuit connecting the two jacks to the ground, or common-return wire. Hence, in order that no appreciable part of the talking current from one subscriber's instrument shall be shunted to the ground at the central office instead of passing on to the other subscriber's instrument, the clearing-out drop must be so wound as to present a very high impedance to the high-frequency talking currents and yet allow enough of the ringing current from a subscriber's generator to pass through it to drop its shutter. Such drops are usually wound to have a resistance of 500 or 600 ohms and should be iron-clad. That is, in addition to a soft-iron core the coil should be entirely surrounded by a shell of soft iron. Such a coil has such a very high impedance for the rapidly alternating talking currents that no appreciable part of these currents can get through it. However, the ringing-off current, which has a very much lower frquency, can readily flow through it and cause the shutter to drop.

Since the annunciators, D and D^1, are not connected to the circuit when the subscribers are talking, they can be made of any suitable resistance such that the subscriber's generators will operate them. They are usually wound to have from 80 to 100 ohms. If the annunciators, D and D^1, are wound to 500 or 600 ohms and made iron-clad like the clearing-out drop, CO, they could be permanently connected between the line and the ground or common-return wire and not arranged to be cut out upon the insertion of a plug in the jack. In this case they would both act as clearing-out drops as well as annunciators and no third clearing-out drop, CO, would be necessary. One objection to this arrangement is that it would put two annunciators across the talking circuit instead of only one; moreover the subscribers' generators would have to furnish twice as great a volume of current as in the arrangement here shown.

STARTING AND STOPPING DIRECT-CURRENT DYNAMOS OPERATED IN PARALLEL.

BY ALTON D. ADAMS

When two or more shunt-wound dynamos are to be started on a circuit not supplied from any other source, the switches for all of the dynamos may be closed before the start is made, and the dynamos allowed to build up and take the load as their speeds increase. In the use of this method it is necessary to place the rheostat levers at such positions that the dynamos will divide the load in suitable proportion, or else to adjust the rheostats continually as the magnet frames build up. If all of the dynamos are brought to full speed before the rheostat levers are moved from the "dead" positions, the dynamos may then be brought into action properly by simultaneous adjustment of all of the rheostat levers. Where a shunt dynamo is to be put into operation on a circuit with others already at work, the dynamo should have its terminal e.m.f. adjusted to just the voltage of the bus-bars and its main switch should then be closed. If the adjustment of pressure is exact, the newly-started dynamos will neither take nor deliver current when its switch is closed, and the rheostat may subsequently be shifted until the machine assumes its share of the load. As the dynamo begins to deliver current to the system, the rheostat levers of the other dynamos must be so shifted as to weaken their magnets, otherwise the voltage of the system will increase as the dynamos first in operation give up a part of their loads to the new machines and consequently have smaller internal losses of pressure. If several shunt dynamos are running in parallel and one is to be removed from the circuit, the rheostats of each dynamo should be adjusted until the one to be disconnected neither takes nor delivers current, when its main switch may be opened without changing the voltage of the system.

Two or more compound dynamos may be started on a circuit not previously in use, in the ways described for shunt machines, provided, of course, that the necessary equalizer connections are made. If a compound dynamo is to be started on a circuit where others are already in operation, any one of several methods may be followed. These methods vary as to the time at which the equalizer connection is made with respect to the making of the main positive and negative connections. According to one plan, the equalizer connection is made permanent on all of the dynamos. This arrangement leaves the series coils of all dynamos constantly in circuit, whether one or more machines are in operation.

To start an additional dynamo on a circuit where others are at work, all of the series coils being constantly in circuit, it is only necessary to so adjust the rheostat of the dynamos to be added to the circuit that its voltage equals that of the system, and then to close the switch that connects the positive and negative wires of the dynamos to the circuit. The rheostat of the dynamo just started should next be manipulated until the dynamo takes its share of the total load. When the switch for the newly-started dynamo is closed there should be no change in the voltage of the system, but as its rheostat is adjusted to give the fresh dynamo a part of the load, the voltage of the system will rise slightly unless the rheostats of the other operating dynamos are shifted so as to lower their generated pressure. To disconnect a dynamo from the system just considered its rheostat should be changed so that the dynamo neither delivers nor takes current, and its main switch can then be opened without effect on the voltage of the system. While the load on one dynamo is being reduced, the rheostats of the other dynamos should be adjusted to keep up their voltage.

A much-used plan for throwing in a compound dynamo includes the use of a triple-pole switch adapted to connect in the positive, negative and equalizer leads of the machine simultaneously. Before a compound dynamo is connected in this way its rheostat should be adjusted to bring the dynamo voltage to equality with that of the system. At the instant the triple-pole switch is closed, the series coil of the added dynamo is put in parallel with those of the dynamos already in operation, and the new coil takes a share of the total current, that is determined by its resistance. The increase of ampere turns on the magnet frame of the added dynamo, by the current thus supplied to its series coil, raises the pressure generated by the dynamo, and it at once assumes a part of the load. If all of the dynamos in operation, including the one last added, are compounded for constant pressure, by the division of the total current between their series coils, the voltage of the system is not changed by the dynamo last started.

Should the current in the several series coils operate to over-compound all of the dynamos equally, two undesirable results are produced at the moment a fresh dynamo is connected. These are an increase in the voltage of the system and a transfer of a disproportionate part of the total load to the dynamo last added, provided, of course, that its capacity is not so exceeded that its overcompounding property is lost. For example, suppose that an over-compounded dynamo which has a terminal e.m.f. of 220 volts at no load, and 240 volts at full load, will also show a rise to 255 terminal volts at full load if started with the rheostat adjusted for a terminal e. m. f. of 240 volts at no load. Let this dynamo be in operation, delivering full load at 240 volts, and let a similar dynamo be brought to the terminal pressure of 240 volts, with no current in its series coil, and then connected to the bus-bars by a triple-pole switch, one blade of which puts the series coils of the two dynamos in parallel. The dynamo just added will increase the voltage of the system and the terminal pressure to about 248 volts, because its series coil will get one-half the total current, and the armature will take the entire load. The dynamo first in operation will have generated in its armature an e. m. f. lower than 248 volts and will take current as a motor from the bus-bar. The rise in voltage of the added dynamo, its assumption of the entire load, and the motor action of the dynamo first in operation can, of course, be checked by the prompt adjustment of the shunt rheostats, but these conditions are not desirable.

The use of overcompounded dynamos, especially in railway power plants, has brought into favor the plan of closing the equalizer connection of a dynamo which is to be cut in on a working circuit before the armature circuit is closed. As soon as the series coil of the starting dynamo is connected in parallel with the others the rheostat should be adjusted to bring the terminal pressure of the fresh dynamo to that of the system, when the switch completing the armature connection may be closed. The closing of this last switch should not change either the voltage or the load distribution of the system, and the dynamo last added may now be given its share of the load by further rheostat adjustment. An objection to this method arises from the fact that when the additional series coil is put in parallel with those at work, it takes a part of their current and thus lowers the voltage of the system, necessitating the immediate adjustment of the shunt rheostats. In the case of a dynamo operating at 240 volts and full load, above cited, if the series coil of a duplicate dynamo is put in parallel with the coil of the first before the armature of the second dynamo is connected, the voltage of the system will drop to the terminal e.m.f. of the first dynamo; that is, from 240 to 230 volts. A quick adjustment of the rheostat for the first dynamo is the best that can be done to check this drop of voltage.

Failure to keep in mind the distinction between dynamos compounded for constant terminal e.m.f. and those that are overcompounded has apparently led to the incorrect statement that an over-compounded dynamo, when adjusted until its terminal e.m.f. equals the voltage of a system with no current in the series coil, and then connected to the system in multiple with a similar dynamo already operating, does not raise the voltage of the system. A dynamo compounded for constant terminal e.m.f. increases its internal generated e.m.f. with its load, though the terminal volts remain the same for all loads. But an over-compounded dynamo not only increases its internal generated e.m.f., but also its terminal e.m.f., as its load or the current in its series coil increases. Consequently, an over-compounded dynamo, when adjusted to the voltage of a system with no current in its series coil must raise the voltage of the system when connected so that the series coil receives current.

The permanent connection of all series coils in parallel makes it possible to put dynamos in and out of service with the minimum of disturbance to the voltage of the system or to the distribution of loads, but such permanent connection is open to the objection that the series windings on each dynamo constantly have current in them. A three-pole switch for each dynamo, to connect the positive, negative and equalizer cables to the operating system simultaneously, is fairly satisfactory with series coils that compound for constant pressures. One disadvantage in this case is that when a dynamo is disconnected from a system in operation the series coils of the remaining dynamos receive an increase of current and consequently raise the voltage of the system. The use of a three-pole switch seems best suited to evenly-compounded dynamos, especially for incandescent lighting, where any drop in voltage is very objectionable. For over-compounded dynamos that arrangement of switches which allows the series coil of a newly-started dynamo to be put in parallel with the coils of operating dynamos before the armature circuit is closed generally is more desirable than the triple-pole switch. With large units on railway work, where a small drop in voltage is less objectionable than extreme fluctuations of load distribution, the independent switch arrangement is decidedly preferable.

THE SPRAGUE MULTIPLE-UNIT RAILWAY SYSTEM.

BY EDW. CHILTON.

The multiple-unit system takes its name from the fact that it has to do with trains made up of many units, any one of which is an independent converter of electrical energy into mechanical energy, so that a single car or a train of 25 cars or more can be started and controlled as smoothly and with much more flexibility than can a train pulled or pushed by a single motor-unit. Such a system is admirably adapted to handle trains under elevated or other steam-road conditions, for, as will be seen later, it has many strong features that combine to save labor, time and material in operation, and the cost of maintenance of roadways and structures.

In a multiple-unit train every coach has its own motor, controllers, resistances, car-wiring cables, air brake, hand brakes, heat and light fixtures, and trolley, plow or contact shoe for transmitting current from the line to the motive and auxiliary apparatus on the car. The main distinctive feature introduced on multiple-unit trains is that the whole train or any part of it can be operated from any controller on any coach. Take any number of single ordinary surface trolley cars, for example, equipped with any style of motors and K2 controllers, and extend their car wires as indicated in Fig. 1, providing the ends with suitable couplers so that any number of cars can be electrically connected. In Fig. 1 A A are the taps that go to the controllers on one car, and B B are the taps that go to those on the other; C, C and C are the couplers. The result of so connecting two cars or more is to place all of the motors on the same set of car wires so that all of them or any of them can be operated from any controller.

Such a train of cars would constitute a multiple-unit train system, but such a system is open to several very serious objections. In the first place, such an arrangement necessitates the transmission and handling of large currents. For example, if the controller on one of the end cars is being used, the current from all of the cars has to pass through that controller. Suppose that the train has six coaches and that each coach, when the train is under full headway, takes a current of 300 amperes. Now the wiring on the last car in the train has to carry only its own current of 300 amperes, but the wiring on the car next to it has to carry the current of two cars, or 600 amperes, and the wiring on every car must carry its own current and that of all cars behind it, so that the wiring and the controller on the first car must handle 1800 amperes—the current of six cars.

As any car is liable to be the front end or operating car, if the full benefit of the multiple-unit feature is to be enjoyed, the wiring of every car must be able to stand with safety a normal current of 1800 amperes and an abnormal current of perhaps twice this during the period of acceleration. The cost of the car wiring alone for such a system would evidently be prohibitive. Also, it would be impracticable to construct a controller of reasonable size that could satisfactorily handle currents of 3000 or 4000 amperes, as it would be required to do at times.

A third and more serious objection is the impracticability of making a coupling device to satisfactorily transmit large currents from one car to the other; such a coupling must necessarily be flexible, so that it may respond to the various contortions and vibrations of the train; and it must be light, so that it can be easily handled when taking on or cutting off an additional coach. The fulfillment of either of these requirements is practically impossible under the conditions. The fourth objection to such a system is that the current for the whole train must be collected by one car, for the current cannot get through the controller on any car except the one whose controller is in use.

Any system, then, that requires the transmission of the main working current from one car to another must be set aside as undesirable. The main working condition to be fulfilled in the design of any multiple-unit system of control is that the working current be delivered directly to the car that utilizes it. Every car must have its own trolley pole and wheel or contact shoe, as the case may be. Suppose a train of six ordinary trolley cars, equipped as usual, and mechanically coupled, but electrically independent of each other; further suppose that by a system of signals the six motormen on the cars could be made to operate their respective controllers in synchronism; that is, all the controller drums to advance or retard at the same rate and rest on the same notch at the same time. Such a train of cars, with a motorman on each car, all acting under the same impulse, would be a multiple-unit train; but such an arrangement, besides being almost impracticable, would defeat one of the strongest arguments in favor of the multiple-unit system of control, namely, that of economy in operation.

There have been several devices designed to take the place of the motorman on each car, and all of them are practical and ingenious. On all of the systems, of which there are three, the car has the ordinary equipment of motors and resistances. In one system there is no individual motor controller of the usual type; the resistance is cut in and out and the series-parallel combinations of the motors are effected by means of electromagnetic switches, operated by means of a small switch situated on the platforms of the car, and known as the master controller. In another system the main controller drum and all of its accessories are operated by means of compressed air, stored in a reservoir and admitted to cylinders whose pistons operate the controller mechanisms; the air supply is controlled by means of valves actuated by electromagnets, energized by dry or storage cells. The battery circuit includes a small controller, situated on the car platform, and called the operating box.

In the system that forms the specific subject of this article—the Sprague system—the main controller is rotated by means of a small motor connected to the drum shaft. The motor is controlled by means of a small platform controller called the master controller. On all three of these systems there are two independent sets of circuits on each car, one being the main motor circuit, and the other the control circuits; there is no electrical connection whatever between them. In fact, on the Westinghouse system this condition is emphasized by the fact that the main motor circuit is, of course, operated by current from the trolley, while the control circuit is operated by battery current. In all cases the main motor circuit bears about the same relation to the control circuit that the telegraph-pole line has to the local sounder circuit inside of the office.

In the case of a multiple-unit car the control circuit is closed first; this operates a mechanism—an air valve, or electromagnetic switch or a motor—which closes the main motor circuit to start the car. Fig. 2 is a car-wiring diagram of the Sprague system of control as applied to a car equipped with two motors. Here, the heavy lines all belong to the main motor circuits; they represent wires and connections that carry the main current that propels the car. The light lines represent the connections of the control circuits; M is the main controller drum and *m* is the control-circuit part of the main drum; it is mounted on the same shaft, but has no electrical connection in common with any of the main motor connections, save the

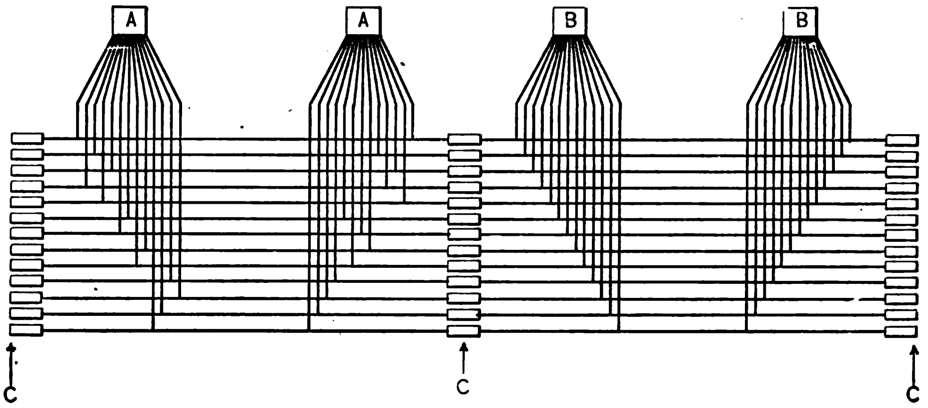


FIG. 1.—DIAGRAM OF CONNECTIONS BETWEEN TWO CARS.

ground connection, which is necessarily in common to all devices working on a ground-return circuit; P is the armature of the pilot motor that drives the main controller; F 10 and F 14 are the two field coils of the pilot motor (these two coils are so connected that when one of them is used the pilot motor runs in one direction, putting the main controller "on," and when the other field coil is used the direction of the motor is reversed, running the controller "off"); B¹ is a solenoid coil in series with the pilot motor, which releases a spring-impelled clamp brake that stops the motor immediately the current ceases to flow through it. The brake and motor are so related that when the motor is "on" the brake is "off," and when the motor is "off" the brake is "on."

A is a seven-section resistance coil, which is unique in that the conductor is an air-insulated iron casting. Fig. 3 shows how each leaf of the resistance coil is constructed. These leaves are mounted on a substantial slate base and allow the currents of air to have a clean sweep through them. The reverser is a drum operated by two electromagnets, as indicated in Fig. 4. As the current entering the junction of the two solenoids, which are in multiple, takes the path, *a*, *b*, through one coil or the path, *a*, *c*, through the other, the reverser drum is pulled one way or the other against the restraining tension of a strong centralizing spring. The reverser coils are a part of the control circuit, and the reverser cannot be operated, and hence the car can not be started, unless the control circuit is in order. Furthermore, if this circuit should get out of order while the car is under headway the reverser coils become dead and unable to hold the drum against the pull of the spring, which brings it back to the "off" position.

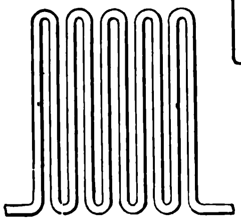


FIG. 3.

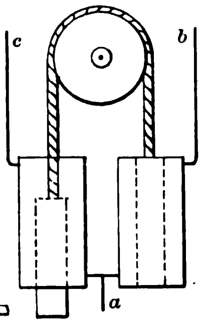


FIG. 4.

Both the reverse and main drums are provided with powerful magnetic blow-out coils to prevent arcing. The reverser drum, like the main drum, carries contacts for both the main motor circuit and the control circuit, but there is no electrical connection between them; L and L are two line switches that admit current to the pilot motor and to the reverser; both must be closed in order to operate the car, and both must be open to entirely "kill" it; T is what is called the throttle; this device makes it impossible to accelerate above a predetermined rate and saves the apparatus much abuse. It will be seen that the main current flows through it. If this main current rises above a certain value the plunger lifts the copper disc off the pegs 10 and 18, interrupts the pilot-motor circuit and stops the advance of the main drum; as soon as the current falls to the limiting value the disc drops, the motor starts and the controller resumes its progress.

The three solenoids, A, B, C, to the right of the throttle are called relays and are a part of the control apparatus. The left-hand relay, A, is called the coast relay, because it is used to run the main controller down to the "off" position, when it is desired to have the train coast along without power; the relay, B, operates to start the pilot motor and run it up to the last series notch, but no further; and the relay, C, runs the pilot motor up to the last multiple notch. The master controller, K, controls the pilot motor and the reverser coils. This controller has a neutral

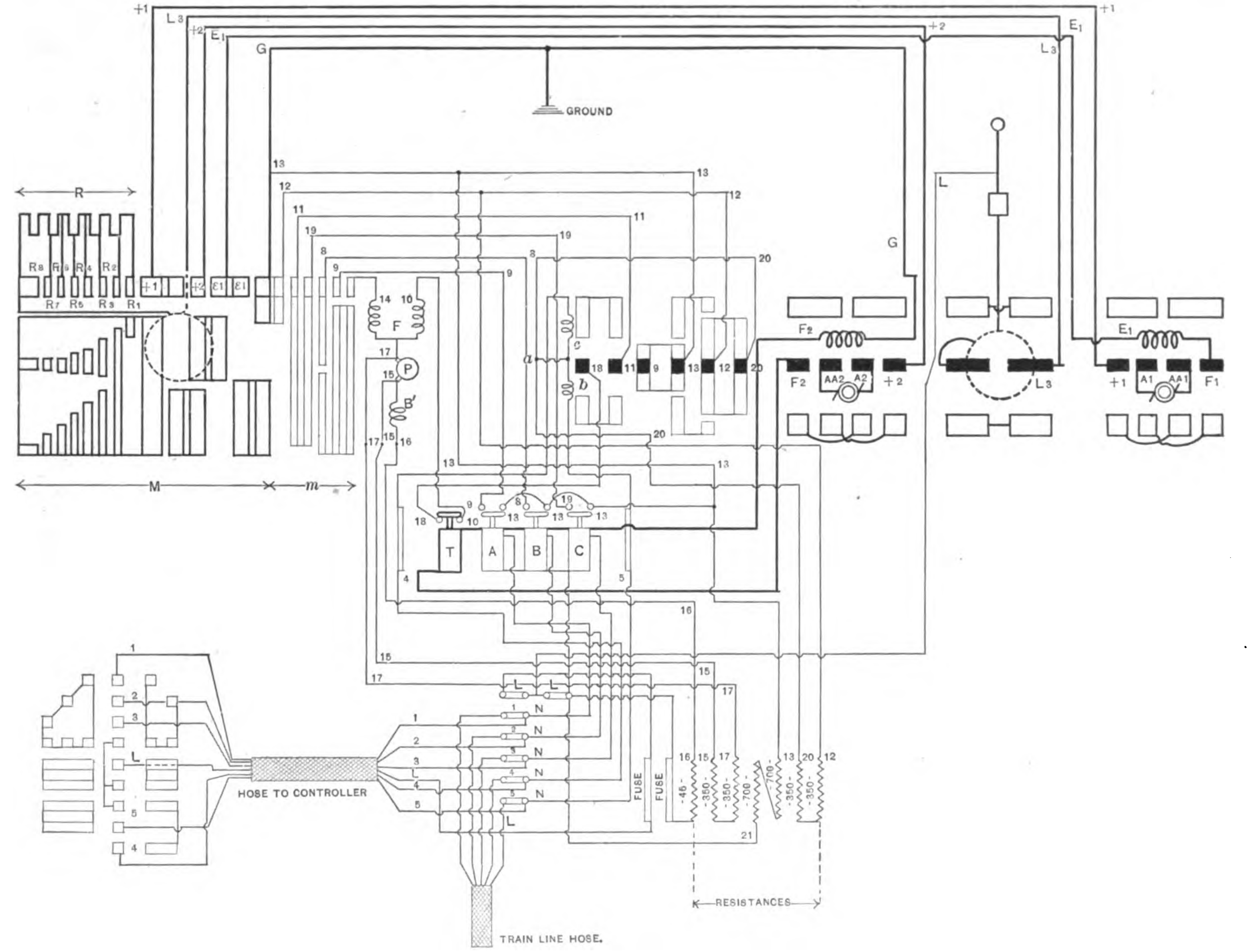


FIG. 2.—CAR WIRING DIAGRAM OF THE SPRAGUE MULTIPLE-UNIT SYSTEM.

position, just as the old Sprague street-car controller had, and the car is started ahead or back according as the controller handle is thrown to one side or the other of the neutral point. There are three forward positions on the controller drum, but only one position marked on the top. There are two reversing positions on the drum, but only one notch marked on the top.

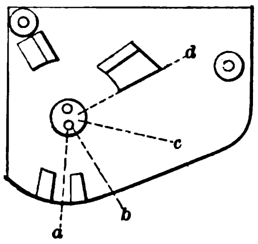


FIG. 5.—CONTROLLER TOP.

Fig. 5 shows the controller top. When the handle is in dotted position, *a*, the controller is at the "off" position; when at position, *b*, the pilot motor does not start, but the reverser drum is thrown to the "ahead" position and the relay, A, is picked up. In the position, *c*, the relay, B, picks up, starts the pilot motor, and this runs the car motor controller up to full-series point, when the pilot motor stops. If the handle be advanced to the position, *d*, the multiple relay, C, operates and the motor controller is run up to full multiple position. This is as far as the handle will go counter-clock-wise. If the motorman releases the handle in this position its spring will carry it back to the position, *b*, but no further, because an interference tongue on the handle goes against the right-hand side of the "off" position lug and stops there. Then the reverser drum remains in position, ready for the next start, but in the meanwhile the relay, A, has operated to run the pilot motor in the reverse direction, so that the main controller drum is run to the "off" position.

In order to get the master-controller handle past the lug to the "off" position it is necessary to press a button which raises the interference tongue on the handle and allows it to pass the lug on the dial. As soon as it passes this lug, the reverser drum is thrown back to the "off" position, in which position the main motor circuit is open in about fourteen places. Should the motorman allow the controller handle to go from any "on" position to the "off" position quickly, it does not give the pilot motor time to run the main drum to the "off" position, so that the main circuit is opened solely by the reverser; but as the reverser opens the circuit in ten places, and as it is provided with a powerful magnetic blow-out coil, indicated by the dotted lines, no arcing can take place.

In order to reverse the motion of the car the master-controller handle must be released from the "off" position, between the lugs, and moved over to the left-hand side. This operates to make the current pass through the other reverser field coil, with the result that the reverser drum is thrown to the "backward" position, reversing the armatures of the two main motors, and with them the direction of motion of the car. As a rule, the motormen run between the positions *b* and *d*, rarely having occasion on the road to drop the reverser back to its "off" position. The series of switches, N, are all operated by a single handle and serve to cut out the train line. The train line is composed of seven very small flexible wires running the full length of the train; these are the wires of the control circuits and carry but little current. They are connected between coaches by means of couplers little larger and no heavier than an ordinary air-brake hose coupler. By means of the train line cut-out switches, one or more cars can be cut out of a train without interfering with the operation of any of the other cars on the train, and the train can even be operated from one of the cars that is cut out.

STEAM INJECTORS FOR BOILER FEEDING.

There are many situations where the injector is pre-eminently adapted for boiler feeding. As it returns the steam it uses to the boiler, it is the most economical method of feeding a boiling, unless there be a waste heat from other sources which may be utilized to heat the feed-water almost up to the boiling point. Considered purely as a pump, it may not seem an economical apparatus, as it uses considerably more steam than an ordinary direct-acting steam pump. The steam, which it uses, however, heats the feed-water very greatly above its original temperature, so that an injector cannot logically be considered merely as a pump, but must be credited with the heat imparted to the feed-water; all of the heat in the steam goes back in the water except the small amount lost by radiation.

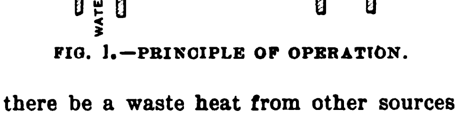


FIG. 1.—PRINCIPLE OF OPERATION.

Injectors are divided into two general classes, single-tube and double-tube. The ability of a single-tube injector to deliver water against a pressure decreases as the height to which the injector lifts the feed-water increases. For example, a prominent type of single-tube injector will deliver against 150 lbs. boiler pressure, if it is not required to lift the water more than 2 ft. If the injector has to lift the water 18 or 20 ft., however, it will only deliver it against 85 lbs. of boiler pressure.

Double-tube injectors are provided with two sets of tubes, one set for lifting the water and the other to do the work of delivering it against the boiler pressure. It would seem from this fact that the height to which the injector is required to lift the water would not affect its ability to deliver it against pressure. That this is not true, however, will appear upon consideration of what happens in the injector. The lifting tubes do all of the work of lifting the water, but when it is brought to the injector chamber, these tubes deliver it to the forcing tubes under a certain amount of pressure, which is added to the force imparted by the jet of steam in the forcing tube. Now, if the lift is so high that the lifting tubes will do no more than bring the water up to the injector, then the forcing tubes have to do all of the work of delivering it; whereas if the lift is short, the lifting tubes will not only lift the water to the injector but turn it over to the forcing tubes under a considerable pressure, thus enabling them to deliver it against a higher opposing pressure than they could alone overcome.

All injectors depend for their operation on the same fundamental principle, to wit:—the condensation of steam in a chamber where it meets the cold feed-water, thus producing a partial vacuum into which more water rushes, and consequently accelerating the flow of the combined steam and water to a velocity so great as to project the water into the boiler against the static steam pressure.

Injectors differ in minor details of design so as to accomplish these ends most efficiently and at the same time render repairs and renewals more readily made, but there is no difference in injector designs so far as fundamental requirements are concerned. Every injector must contain a steam nozzle, which delivers a jet across the water inlet; a combining tube, where the water and steam combine, resulting in the condensation of the latter, and a delivery tube in which the velocity of the stream is reduced. The principle of the condensation being involved, it is evident that the colder the feed-water, the better the injector will operate. It is also evident that there is a limiting temperature beyond which the injector will not work at all.

Fig. 1 shows an outline of an injector illustrating the principle of operation, but without any constructional details. Steam issuing from nozzle, C, at a high velocity, by entrailment exhausts the air from the pipe, B, causing the water to rise; the water mingling with the steam in the chamber of nozzle, D, condenses it, producing a partial vacuum and thereby accelerating the flow of steam and water through the nozzle, D, where it obtains its maximum velocity. If at this high velocity the water were delivered against the quiescent boiler pressure, there would be a great waste of energy, and to avoid this another nozzle with diverging sides is always added so as to effect the desired change of velocity as economically as pos-

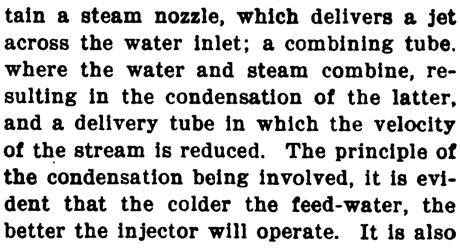


FIG. 2.—METROPOLITAN AUTOMATIC.

sible. The tube, H, shown in the engraving, is introduced for this purpose; the water passes from this tube to the boiler at a reduced velocity. A check-valve, I, is necessary in order to prevent back flow from the boiler in case the injector fails to work, and an overflow outlet, G, is also required for the purpose of rendering the injector free from opposing pressure in starting up.

Figs. 2 to 11, inclusive, represent typical single-tube injectors of American make. The Metropolitan, shown by Fig. 2 and made by the Hayden & Derby Manufacturing Company, New York, is started by rotating the handle just as one does the hand wheel of a valve-stem. As soon as the entrance to the steam nozzle, S, is uncovered, steam rushes through, drawing water up the water-supply pipe into the suction nozzle, V. The condensation takes place in the nozzle, C, and the water is delivered through the tube, D. The check-valve, P, opens into the overflow. The steam nozzle is removable by taking out the plug, O; the delivery nozzle cannot be removed without taking down the boiler connection, A, B.

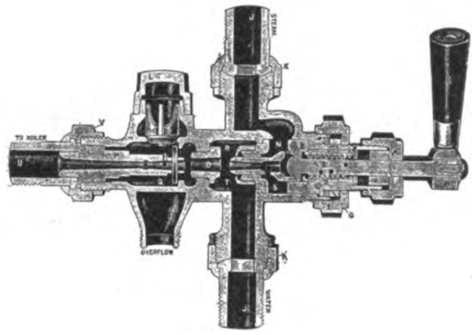


FIG. 3 — BUFFALO INJECTOR

The Buffalo automatic injector, made by the Sherwood Manufacturing Company, Buffalo, N. Y. (see Fig. 3), is generally similar to the Metropolitan. The manipulation is precisely the same, but the removal of the gland nut, E, renders all of the interior accessible and all of the nozzles removable except the delivery tube P. This must come out at the delivery end, as is the case with almost all injectors. The exterior appearance of the machine is quite simple and substantial, as Fig. 4 shows.

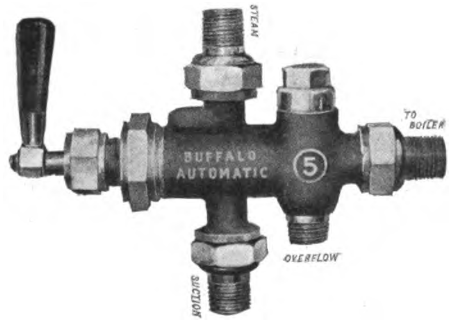


FIG. 4 —BUFFALO INJECTOR.

The Little Giant injector, Fig. 5, has the peculiar feature of a sliding combining tube, K, which is moved toward or away from the steam nozzle by means of the lever, W. The steam valve is also somewhat peculiar; the main admission is through an annular opening around the outside of the valve, 7, and steam is also admitted through holes in the wall of this valve to a "needle" jet which it carries and which delivers near the end of the steam nozzle. The adjustment of the combining tube, K, regulates the water supply. The steam valve is removable by taking off the gland, but the steam connection must be removed to get out the steam nozzle. The combining tube can be taken out by unscrewing its gland nuts and taking off the lever, W. This injector is made by the Rue Manufacturing Company, of Philadelphia, Pa.

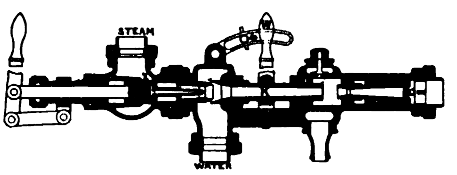


FIG. 5 —LITTLE GIANT INJECTOR.

The Penberthy special injector, manufactured by the Penberthy Injector Company, Detroit, Mich., is a very simple type. There are no adjustments to be made in the machine itself. All that is necessary in order to start it is to open a valve in the steam-supply pipe, which is connected to the upper right-hand union shown in Fig. 6. The steam nozzle is indicated by the letter, X, the combining tube by the letter, G, and the delivery tube by the letter, H. All of these tubes may be removed without breaking any connections, by taking off the screw caps, 4 and 8; the check-valves in the overflow may be removed by taking off the cap, N. Figs. 7 and 8 illustrate the Penberthy automatic injector, which, as will be seen, is of somewhat simpler construction than the special injector shown by Fig. 6. The construction of the injector is evident from Fig. 8. In order to start it, it is only necessary to open a valve in the steam-supply pipe and throttle the flow of water in the boiler-feed pipe until the discharge at the overflow ceases.

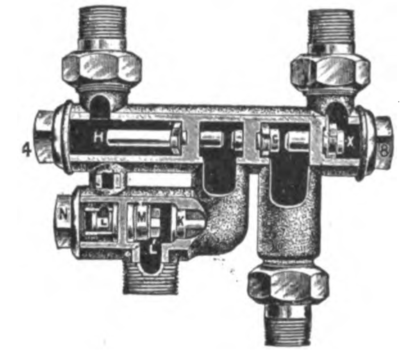
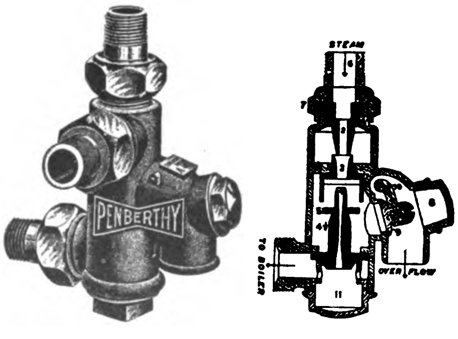
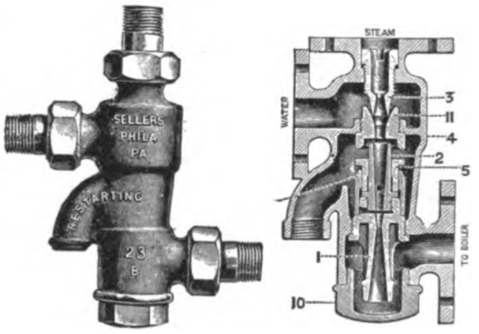


FIG. 6.—PENBERTHY SPECIAL.



FIGS. 7 AND 8.—PENBERTHY AUTOMATIC.

The Sellers restarting injector, shown by Figs. 9 and 10, made by Wm. Sellers & Company, Philadelphia, Pa., is equally simple, there being no valves to manipulate in the injector itself. As its name implies, it is restarting, and it is also a lifting injector. The arrangement for preventing the entrance of air to the overflow is somewhat unusual. The steam enters at the top through the steam nozzle, 3, lifting the water to the injector, and the partial vacuum caused by the condensation of steam in the draft tube, 11, raises the bushing, 5, up against the mouth of the draft tube, preventing the entrailment of air through the overflow outlet. In order to remove the steam nozzle, 3, the steam connection must be broken, but all of the other tubes may be removed from the bottom by taking off the cap, 10. A somewhat unusual feature of this injector is the discharge of water from the delivery tube up against the blank wall of the cap, 10, instead of directly against the check-valve in the boiler feed pipe, which is usually the case. Fig. 9 gives an exterior view of the injector, with screw unions, and the cross-sectional view. Fig. 10 shows it fitted for flange connection.



FIGS. 9 AND 10.—SELLERS RESTARTING INJECTOR.

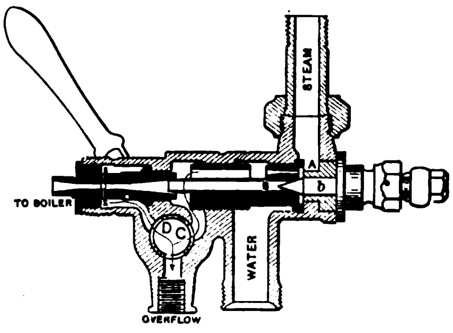


FIG. 11.—EXCELSIOR INJECTOR.

Fig. 11 represents the Excelsior injector, made by N. A. Watson, Erie, Pa. This injector differs from most of the other single-tube machines in that the starting lever closes the overflow outlet after opening the steam valve. The steam valve is a conical plug, indicated by the letter, *b*, in the illustration. The back end of the valve stem is connected to the starting handle by a link, so that throwing the lever over to the right backs the valve out of the steam inlet, B. A further movement of the handle over to the right rotates the plug valve, D C, so as to close the overflow outlet.

Double-tube or compound injectors, as intimated in the opening paragraphs of this article, operate on precisely the same principle as the single-tube type, the difference being merely that the injector is provided with two sets of tubes, one set to lift the water and the other set to force it into the boiler. The Leader injector, Fig. 12, made by the Randle Machinery Company, Cincinnati, Ohio, belongs in this class of machines. It only differs in construction from the Excelsior, just described, in having the auxiliary lifting tubes just above the water inlet. The valve motion is precisely the same as that of the Excelsior injector.

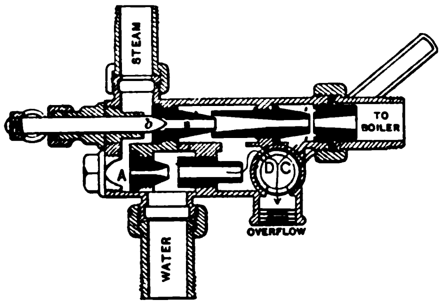


FIG. 12.—LEADER INJECTOR.

Fig. 13 represents the Sherwood double-tube injector, made by the Sherwood Manufacturing Company, Buffalo, N. Y. The operation of the injector will be apparent from the sketch; simply pulling the starting handle outward opens first the valve covering the mouth of the steam tube, 22, and then opens the valve, 2, to admit steam to the forcing tube, 24. The lower set of tubes raises the water to the chamber of the injector, and the upper set forces it into the boiler. The overflow valve, 18, is closed by the lateral movement of the valve cam, 19, which is connected outside the injector by means of a link to the starting handle, the connection being made at the point where the cotter pin is shown. A movement of the cam, 19, to the right allows the overflow valve, 18, to drop against its seat. All of the interior parts, except the delivery tube, 25, are removable without breaking any connections.

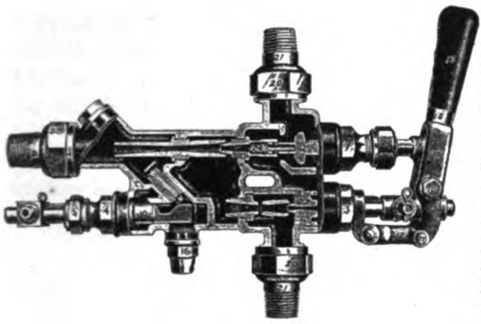


FIG. 13.—SHERWOOD DOUBLE-TUBE.

One of the oldest of the double-tube injectors is the Korting, manufactured by L. Schutte & Co., of Philadelphia, and illustrated by Fig. 14. It is controlled by the movement of a single handle, as is the case with almost all injectors. The lifting nozzle is indicated by the letter A, and the forcing nozzle by the letter B. The lever is connected outside the injector by a link to the overflow valve, which is opened when the injector is shut off and closed after it is started, just as in the case of the Sherwood. Both sets of nozzles are removable without breaking any connections, being in line with the two plug caps shown above and below the center of the machine at the left-hand end.

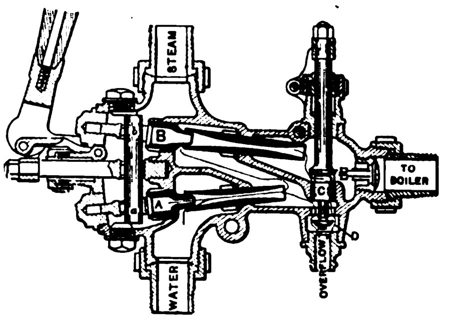


FIG. 14.—KORTING INJECTOR.

A construction somewhat simpler than the Korting is the Niagara, shown by Fig. 15, made by the Eynon-Evans Manufacturing Company, Philadelphia, Pa. The engraving shows the injector adapted to the Sellers standard pipe connection. A feature of the machine, however, is that it may be changed from this arrangement to suit the Monitor pipe connection, which is the standard for railroad work. This is accomplished by interchanging the overflow nozzle, C, with the plug, P, and replacing the water connection, E, with a longer leg or nipple. It is not necessary to manipulate the hand wheel, S, in starting; this is merely for regulating the capacity of the injector. The handle, H, opens both the lifting and the forcing steam nozzles. All of the interior parts except the delivery nozzle may be removed without breaking connections.

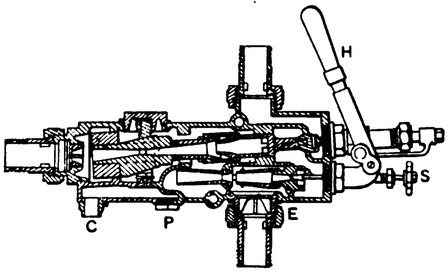


FIG. 15.—NIAGARA INJECTOR.

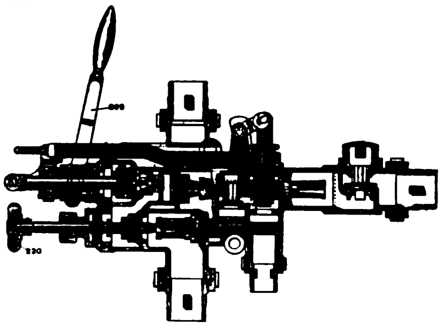


FIG. 16.—METROPOLITAN "1898."

The Metropolitan "1898" injector, Fig. 16, is similar in construction to the Niagara in that it has a separate regulating valve, 220, for adjusting the capacity of the machine, in addition to the starting handle, 269, which admits steam to both the lifting and the forcing tubes and closes the overflow valve. The Metropolitan double-tube injector, "Model G," is shown by Fig. 17. Its operation will be evident from an inspection of the sectional cut. All the tubes of this injector are removable without breaking any of the steam or water conections; a separate valve is required to adjust the delivery of water. The Metropolitan injectors are built by the Hayden & Derby Manufacturing Company, New York.

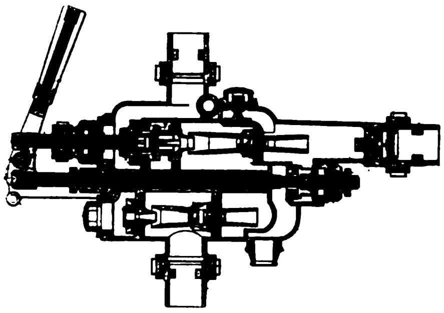


FIG. 17.—METROPOLITAN DOUBLE-TUBE.

The Hancock "inspirator," Fig. 18, is one of the best-known injectors in use in this country. Its manipulation is, however, not so simple as that of the other injectors described. There are three valves to handle on the injector itself and an additional valve in the steam pipe. In starting up, the overflow valves, 1 and 3, must be opened, the forcing valve, 2, closed, and the valve in the steam pipe opened to admit steam to the lifting nozzles on the left. As soon as the water appears in the overflow, the valve, 1, is closed, the forcing valve, 2, opened, which allows the forcing nozzle to carry water to the boiler, and the overflow valve, 3, is closed. This injector is manufactured by the Hancock Inspirator Company, New York City and Boston, Mass.

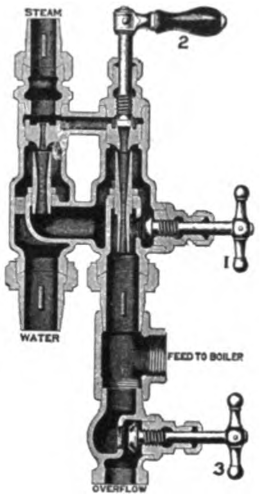


FIG. 18.—HANCOCK INSPIRATOR.

Lessons in Practical Electricity

TRANSFORMER CONNECTIONS.

Two or more transformers built to operate at the same potential and frequency may be connected together in a variety of ways; in fact, the primary and secondary terminals may each be considered exactly as the terminals of direct-current dynamos, with certain restrictions. The two principal precautions which must be observed in combining transformer terminals are that the terminals must have the same polarity at a given instant, and the transformers should have practically identical characteristics. The latter condition is not absolutely essential, but it is emphatically preferable. For example, if a transformer which has 2 per cent regulation be connected in parallel with one which has 3 per cent regulation, as indicated in Fig. 38, at no-load the transformers will give exactly the same e.m.f. at the secondary terminals, but at full-load one will have a secondary e.m.f. of, say, 98 volts, while the other has an e.m.f. of 97 volts. The result is that the transformer giving only 97 volts will be subject to a back e.m.f. of one volt from its mate. This will not cause excessive current to flow backward through the secondary winding of the low-voltage transformer, but it will disturb the phase relations and lower the power factor and efficiency of the combination; in such a case it is much better to work the secondary circuits of the two transformers separately.

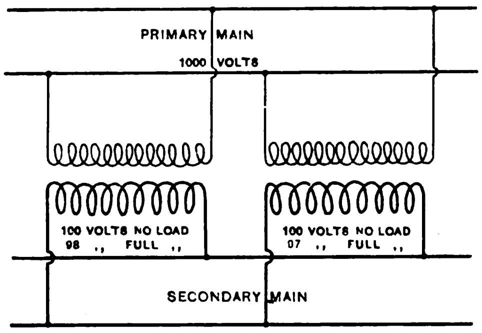


FIG. 38.—UNLIKE TRANSFORMERS IN PARALLEL.

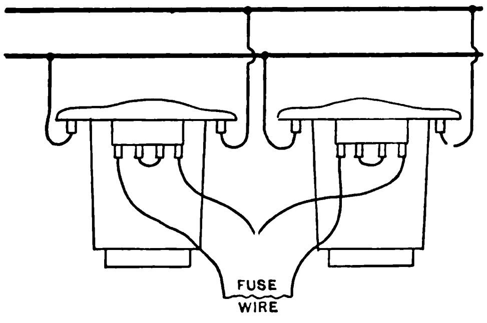


FIG. 39.—COMPARING INSTANTANEOUS POLARITY.

In case the transformers have practically the same characteristics it is necessary, as stated above, to make sure that the secondary terminals connected together have the same polarity at a given instant; it is not necessary to find out definitely what the polarity is, merely that it is the same for both terminals. This can be easily done by connecting two of the terminals as shown in Fig. 39, by a small strip of fuse wire, and then touching the other two terminals together. If the fuse blows, then the connections must be reversed; if it does not, then they may be made permanent. It is seldom advantageous, however, to operate transformer secondaries in parallel; occasionally it may be necessary as a temporary expedient, but where the load is such as to require a greater capacity than that of a transformer already installed, it is much better to replace it by a large transformer than to supplement it by an additional transformer of its own size.

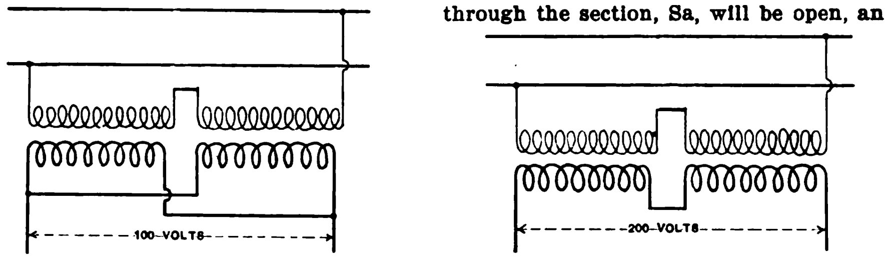


FIG 40.—SECONDARY CONNECTIONS FOR DIFFERENT VOLTAGES

All modern transformers have the secondary windings divided into at least two sections which may be connected up either in parallel or in series. If the secondary e.m.f of a transformer having two sections is 100 volts with the terminals in parallel, then connecting them in series will give 200 volts at the free secondary terminals, as indicated in Fig. 40. If the transformer be of the core type, and the two sections of secondary winding be wound on different limbs of the core, as in Fig. 41, it will be advisable, if the secondaries are to be operated in parallel, to make the connections ample and permanent, so that there will not be any liability to a difference between the current flowing in one secondary winding and that flowing through the other.

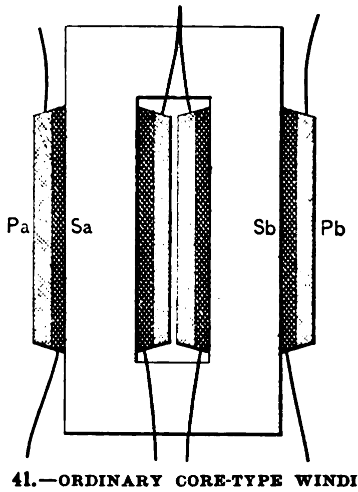


FIG. 41.—ORDINARY CORE-TYPE WINDING.

Still referring to a transformer which has the two secondary sections on different legs of the core, if the secondary terminals are connected up to a three-wire distribution, as shown diagrammatically in Fig. 42, it is advisable to make the fuse, Fc, in the middle wire, considerably smaller than necessary to pass the normal load in either side of the circuit. The reason for this is as follows: Should the fuse, Fa, be blown, the secondary circuit through the section, Sa, will be open, and the corresponding half of the primary winding, Pa, will have a much higher impedance than the half of the primary winding, Pb, the inductance of which is so greatly neutralized by the load on the secondary winding, Sb, as explained in previous lessons. The result will be that the counter e.m.f. of the primary section, Pa, will be very much greater than that of the section, Pb, and as the sections are in series the current must be the same through both halves of the winding; the drop or difference of potential, therefore, between the terminals of Pa will be much higher than that between the terminals of Pb, consequently, the secondary voltage of Sb will be greatly lowered and the service impaired. As the primary winding, Pa, is designed to take only one-half of the total impressed e.m.f., the unbalancing referred to will subject it to a considerably higher e.m.f. than the normal value; consequently, the magnetic density in that leg of the transformer core will be much higher than normal, and the transformer will heat disastrously.

If the fuse, Fc, in the middle wire be made, say, one-half the capacity of each of the other fuses, this condition will be relieved by the blowing of this fuse, and as the lamps in the live circuit would not be anywhere near candle-power if the circuit remained intact, the blowing of the middle fuse will not be any disadvantage to the user of the lamps. Some makers avoid the contingency just described by dividing each secondary coil into two sections and connecting a section on one leg in series with a section on the other leg of the core, so that current applied to

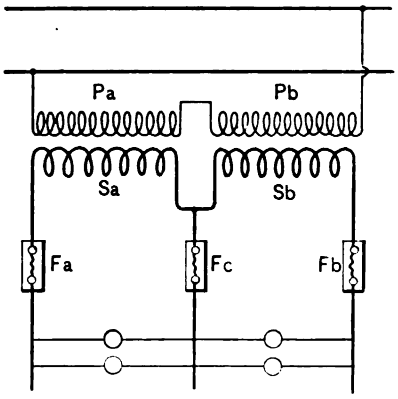


FIG. 42.—THREE-WIRE SECONDARY SERVICE.

either pair of the secondary terminals will circulate about both legs of the core.

In the case of two-phase distribution each circuit may be treated as entirely independent of the other so far as the transformers are concerned. Two transformers are used, one transformer being connected to one primary phase and supplying one secondary phase, and the other transformer being connected to the other primary phase and supplying the other secondary phase, as indicated in Fig. 43, exactly as though each primary and secondary phase were an ordinary single-phase system, independent of the other phase. In such cases it is possible for the two phases to remain electrically independent throughout the system, although it is not customary to thus arrange the wiring.

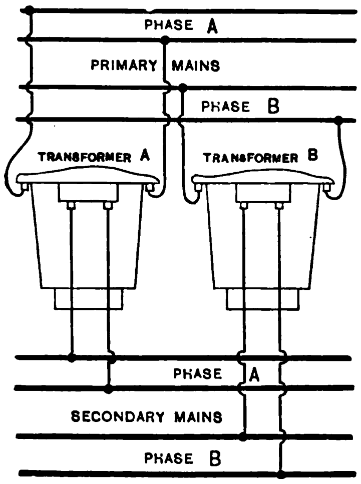


FIG. 43.—TWO-PHASE CONNECTIONS

A method of connection commonly used to obtain economy in wiring is that shown by Fig. 44, where the primaries of the transformers are connected independently to the two phases, and the secondaries are joined to a three-wire distribution, the middle wire being about one-half larger than each of the two outer wires. In the former case, Fig. 43, it makes no difference which secondary terminal of a transformer is connected to a given secondary wire, so long as no transformers are used in multiple. For example, referring to the diagram, the left-hand secondary terminal of transformer, A, could just as well be connected to the lower wire of the secondary phase, A, and its right-hand terminal connected to the upper wire, the only requirement being that the two pairs of mains shall not be "mixed;" that is to say, transformer A must not be connected with one secondary terminal to phase A and the other to phase B. In the case shown by Fig. 44 there is not quite so much freedom in making connections. One secondary terminal of each transformer must be connected to one of the outer wires and the other two terminals must be both connected to the larger middle wire of the secondary system. It makes no difference, however, which two secondary terminals are joined and connected to the middle wire so long as the other terminal of each transformer is connected to an outer wire of the secondary system.

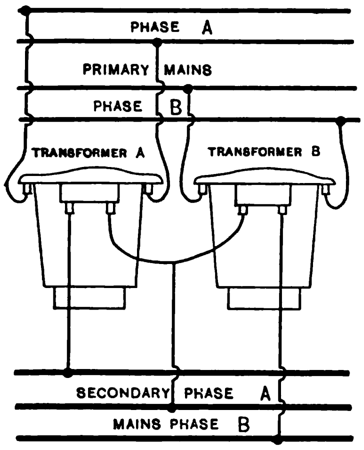
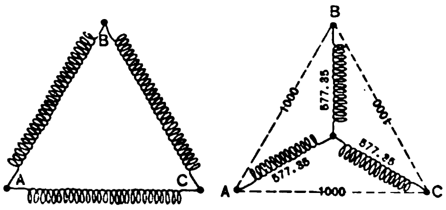


FIG. 44—TWO-PHASE CONNECTIONS; THREE-WIRE SECONDARY.

The methods of making three-phase connections are more rigid, as the three phases are inseparably interlinked. There are two ways of connecting up the primaries and secondaries, one known as the "delta" connection, and illustrated diagrammatically by Fig. 45, and the other known as the "star" connection, and illustrated by Fig. 46. In both diagrams the line wires are lettered, A, B and C. Fig. 47 shows the primaries and secondaries connected up delta fashion, corresponding to Fig. 45, and Fig. 48 shows them connected up star fashion, corresponding to Fig. 46. In both of the latter sketches the secondary wires are lettered to correspond with the respective primary wires. When the primaries are connected up delta fashion, the voltage between the terminals of each primary winding is the same as the voltage between the corresponding two wires of the primary circuit, and the same is true of the secondary transformer terminals and circuit wires.



FIGS. 45 AND 46—DELTA AND STAR DIAGRAMS.

The current, however, flowing through the transformer winding is less than the current in the line-wire, for the reason that the current from any one line-wire divides between the windings of two transformers. For example, in Figs. 45 and 47, part of the current from the line-wire, A, will flow from A to B through the left-hand transformer, and part from A to C through the right-hand transformer; if the current in the line-wire, A, is 100 amperes, the current in each transformer winding will be 57.735 amperes. When transformers are connected up star fashion, as in Figs. 46 and 48, the current in each transformer winding is the same as that in the line-wire to which it is connected, but the e.m.f. between the terminals of each transformer winding is 57.735 per cent of the e.m.f. from wire to wire on the circuit. For example, if the primary e.m.f. from A to B is 1000 volts, the e.m.f. at the terminals of the left-hand transformer (from A to J) will be only 577.35 volts, and the same is true of each of the other transformers if the system is balanced.

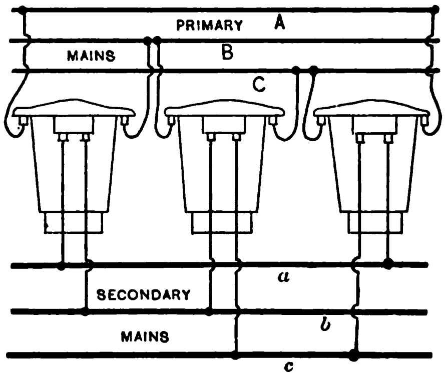


FIG. 47.—THREE-PHASE DELTA CONNECTIONS.

These statements apply, of course, to both primary and secondary windings, from which it will become evident that if the three transformers of a three-phase circuit be connected up star fashion at the primaries, and delta fashion at the secondaries, the secondary voltage will be lower than if both sides are connected up star fashion. For example, if the transformers are wound for a ratio of 10 to 1, and are connected up with both primaries and secondaries alike, no matter whether it be delta fashion or star fashion, the secondary e.m.f. will be one-tenth of the primary e.m.f.; but if the primaries be connected up star fashion on a 1000-volt circuit, and the secondaries be connected up delta fashion, the secondary voltage will be only 57.735 volts, instead of 100 volts. The explanation of the difference between the voltage per coil in a delta system and that in a star system is that in the former each winding is connected directly across from wire to wire; whereas in the star system, two windings are in series between each pair of line-wires. The voltage of each winding is not reduced to one-half, however, because the e.m.fs. are out of phase with each other, being 120°, or one-third of a cycle, apart; consequently, instead of having 500 volts at the terminals of each coil in Fig. 46, the voltage is 577.35. The same explanation applies to the current values in a delta system. The current phase between A and B, in Fig. 45, is 120° removed from that in the winding between A and C; consequently, the sum of the two currents, in the wire, A, is 1.732 times the current

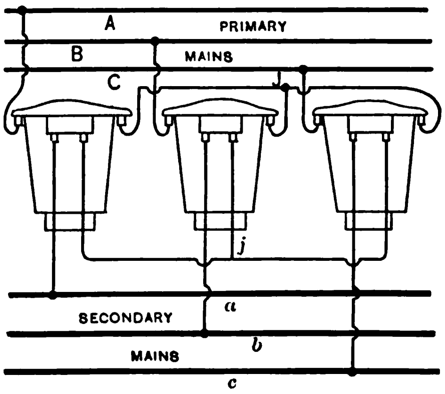


FIG. 48.—THREE-PHASE STAR CONNECTIONS.

in each wire; or, to state it the opposite way, the current in each winding is .57735 of the current in the wire, A. It will be well for the reader to remember that in all cases e.m.fs. differing in phase when connected in series, combine according to the well-known law of the parallelogram of forces; currents differing in phase, and connected in parallel, combine according to the same law.

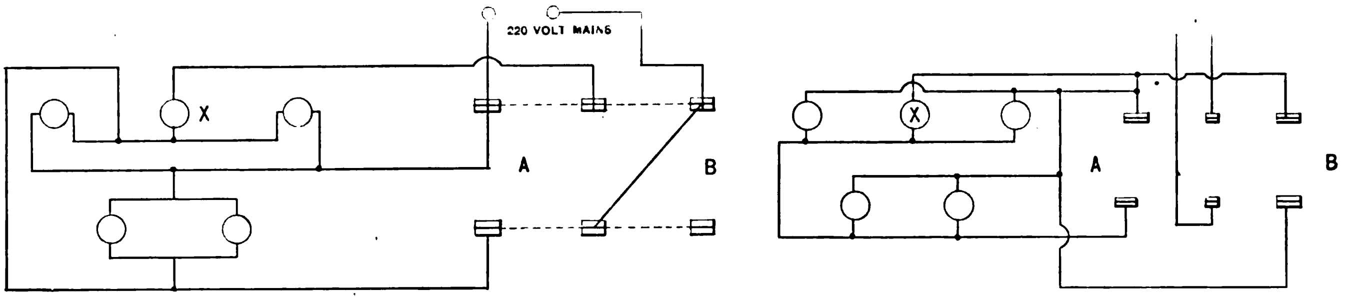
Letters on Practical Subjects

Electric Bells on Lighting Circuits.

To the Editor, American Electrician;

Sir:—Referring to Mr. Root's method of connecting electric bells on lighting circuits which was published in your December number, I beg to suggest that a still simpler method would be to connect a small resistance coil in series with a lamp across the electric light mains, and connect the bell and its push button in shunt with the resistance coil. By this means the proper voltage can be obtained at the terminals of the bell, and the lamp may be used in the ordinary manner for lighting purposes. A. R. Van Volkenburgh.

Chicago, Ill.



FIGS. 1 AND 2.—WIRING PUZZLE SOLUTIONS.

◆

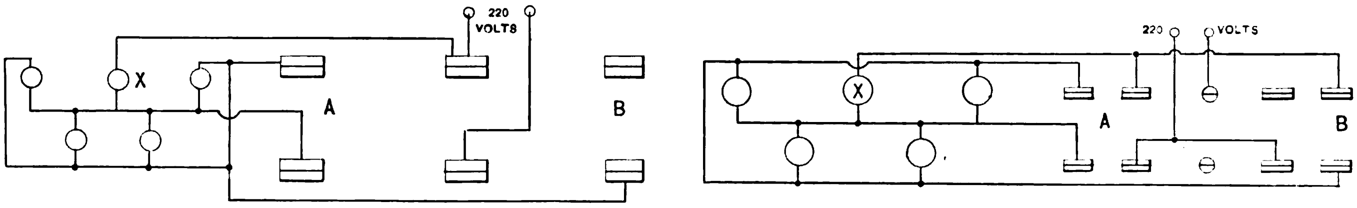
A Wiring Puzzle.

To the Editor, American Electrician;

Sir:—I send herewith a diagram (Fig. 3) which solves the puzzle submitted by Mr. Havens in the December number of the American Electrician. One side of the lamp, X, is connected permanently to one side of the supply circuit, the pressure of which is 220 volts. With the switch thrown over to A all of the lamps are in parallel, and when it is thrown over to B the lamp, X, is in series with the other four, which remain in parallel.

Geo. W. Malcolm.

Brooklyn, N. Y.



FIGS. 3 AND 4.—WIRING PUZZLE SOLUTIONS.

To the Editor, American Electrician;

Sir:—I send herewith a diagram (Fig. 2) of wiring in answer to the letter from A. L. Havens in the December number. The voltage of the circuit is the same as that of the lamps, 220 volts; I do not see how it could be anything else. With the switch in position A, all of the lamps burn; in position B, only the lamp, X, burns. It may be well to add that the reason for this is that the lamp, X, is in series with the other four lamps, which are in parallel when the switch is thrown over to B. Consequently, the four lamps in parallel do not show any light, and as they are turned out one by one the resistance of the group is increased, cutting down the current through the lamp, X, until all of the four lamps in parallel are cut out, when the circuit through X is opened.

Lockport, Ill. Ralph G. Focht.

To the Editor, American Electrician;

Sir:—I believe the accompanying diagram (Fig. 1) to be a solution of the wiring puzzle published on page 584 of the December number. When the switch is thrown over to the side, A, all of the lamps are in parallel on the 220-volt circuit; when the switch is thrown over to B, the lamp, X, is in series with the other four, which are in parallel. Fred Dustin.

Minneapolis, Minn.

To the Editor, American Electrician;

Sir:—Referring to Mr. Havens' wiring puzzle in the December number, it is not stated whether the switch to be used must be single-break or double-break. Assuming from this that one is at liberty to use whichever he pleases, I submit the accompanying diagram (Fig. 4) as a solution of the problem. It will be noticed that one side of the supply circuit is connected to the switch pivot instead of the jaws, while the other side is connected to the two inner jaws, as usual. This is necessary in order to change the connection between one side of the lamp, X, and one side of the group of four lamps. A single-break switch could be used, but in this case the upper side of the lamp, X, would have to be connected directly to the side of the circuit which is shown connected to the switch pivot. The explanation of the different phenomena described by Mr. Havens is that when the switch is over to the side, A, all of the lamps are in parallel, and burn at full candle-power; when it is thrown over to B, the lamp, X, is in series with the other four, which are in parallel, and consequently the lamp, X, burns not at full candle-power, while the other lamps do not show the current that is passing through them because of the very small amount passing through each lamp. As the four lamps are switched off one by one, the resistance of the group increases, cutting down the current and consequently the brilliancy of the lamp, X; when the final lamp of the four is switched off the circuit is opened and the lamp, X, is extinguished.

W. C. Townsend.

New Orleans, La.

[All of the above diagrams fulfill the requirements specified by Mr. Havens with the exception of Fig. 2. This diagram fails because the lamp, X, is permanently connected in parallel with the two lamps on each side of it by means of the cross-connection near the upper left-hand switch jaw. It seems evident that Mr. Focht intended this connection to be broken when the switch is thrown over to the side, B, as his explanation of the effect of switching out the various lamps is entirely correct; the diagram, however, does not show this.

Fig. 3 also represents a solution sent in by Mr. A. R. Van Volkenburgh.—Editor.]

◆

Unusual Action of an Arc-Light Dynamo.

To the Editor, American Electrician;

Sir:—The electric light company here operates a Ball double-armature arc dynamo with the two armatures connected in series in the circuit. One night recently upon starting up the machine everything ran all right for a few moments and then the lamps died out. I shifted the brushes around the commutator to the no-voltage point and then threw them back again; the circuit lighted up, but in a few minutes died out again. This operation was repeated several times and it was noticed that one of the journal boxes of the armature shaft ran excessively hot as long as the brushes were in the normal position and cooled off when they were shifted up to the no-voltage position. After a while it was noticed that the brushes of one commutator were turned under, and upon close examination it was discovered that that armature and commutator were running backward at a high rate of speed.

The armature had become loose on the shaft and the main-line current was driving it backward as a motor. When the brushes were in the normal position the counter e.m.f. of this armature ran up and cut down the e.m.f. of the belt-driven armature so that the circuit died out; when the brushes were thrown up to the no-voltage position the counter e.m.f. of the loose armature was zero and the circuit picked up again when the brushes went back to the commutating position, only to be again killed by the speeding up of the loose armature. The heating of the journal was due to the fact that the armature spider was revolving around the shaft in the opposite direction of the rotation of the shaft itself and therefore heated the shaft. When the brushes were thrown to the no-voltage position the armature slackened its speed and the heating decreased. This occurrence is such an unusual one that I submit it thinking that it will prove of interest to others who have dynamos of this type.

E. C. Sutton.

Iowa Falls, Ia.

Electric Car Troubles.

To the Editor, American Electrician;

Sir:—Any railway superintendent bothered with leaks and burn-outs of fuse boxes in winter, owing to leakage, will find the following a remedy for this annoyance. Fit four porcelain insulators very tightly into the fuse-box base, and fasten with wood screws, as shown by Fig. 1. As the engraving shows, there is a space between the fuse-box and the car-sill. This will do away with sheet rubber and insulating paint, which afford only temporary relief. Better still is an insulator provided with a brass female screw thread imbedded in the sill, except ¼ in., which should extend beyond the sill for the fuse-box to bear against, as shown by Fig. 2.

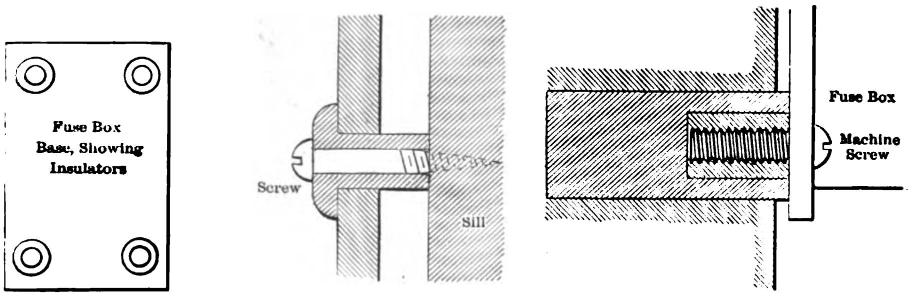


FIG. 1.—ELECTRIC CAR TROUBLES —FIG. 2.

The cause of a tie-up for an hour or more, one rainy, disagreeable day, was the band wires coming off an armature. The car was on a six-mile line, running to a pleasure park—the only line controlled entirely at the power-house switchboard. We opened that circuit, and found the ground was on that line. It had occurred in this way: After fusing several times, a heavier fuse had been put in, and when the power came on again, the controller was on the first notch, where it had been left by the motorman so that he might know when the current came on. As it happened, several strands of the wire had wrapped themselves about a brush holder and made contact with the frame also. The fuse was just large enough to knock out the circuit-breakers.

Of course, if the motorman had had his controller off, the circuit-breakers would have opened only when he tried to start. Some men are sharp enough to suspect their car as being the one causing trouble in these cases; so they wait until the power has been on the line for some time. If the power goes off as soon as they attempt to start, a close search often locates the fault, which can then sometimes be remedied without calling on the inspector. It should nevertheless be reported as soon as possible.

A glance at the station ammeters when closing the line circuit-breakers often reveals the fact that many men resort to the practice of leaving the controller on first notch, instead of using the lamp circuit to indicate when the power is again on the line.

A. B. Weeks.

Niagara Falls, N. Y.

The Control of Lights From More Than One Point.

To the Editor, American Electrician;

Sir:—The method of wiring incandescent lamps for control from different points which was described by Mr. Van Vleet in your December number is one which is commonly used and the only one that I have ever seen described in wiring books. The accompanying diagrams, Figs. 1, 2 and 3, show a method which I have used and which is more economical in wiring than the other one. The only difference is in reversing the relation of the three-point switches to the circuit. The result of this is that only one stretch of wire is necessary between the two three-point switches. Fig. 1 shows the arrangement for two stations or switches, Fig. 2 shows the arrangement for three stations, and Fig. 4 that for four. Any number of stations may be connected up by simply adding four-point switches. In the old method the two end switches are three-point, while all the intermediates are four-point switches. In the method here shown the three-point switches are placed at each end of the stretch of wire which includes the lamp or lamps to be controlled. It is evident that the greatest advantage of this arrangement is where there are only two stations, as in Fig. 1, because here the amount of extra wire required between switches is only one-half that required by the method more generally used and described by Mr. Van Vleet.

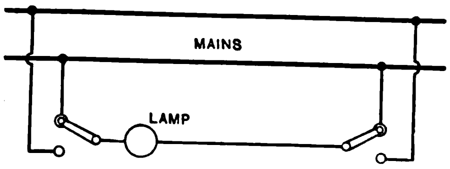


FIG. 1.—TWO-POINT LAMP CONTROL.

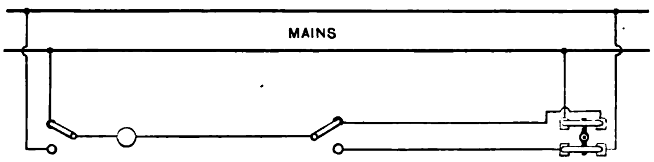


FIG. 2.—THREE-POINT LAMP CONTROL.

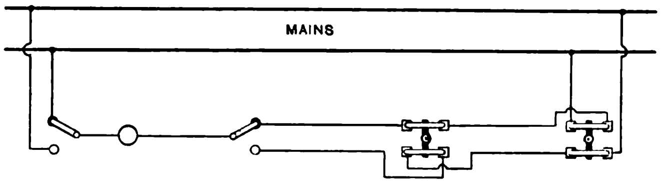


FIG. 3.—FOUR-POINT LAMP CONTROL.

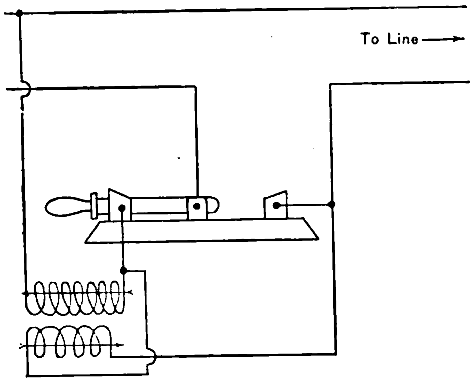
Francis M. Appleton.

Boston, Mass.

An Improvised Booster.

To the Editor, American Electrician;

Sir:—Some time ago I had to face the problem of running a 1000-volt primary circuit across a river too wide to hang copper wire across, and also too wide to use steel wire without getting a drop so great as to bring the voltage at the far end down entirely too low for the service. It was evidently a case of boosting the voltage, but I did not have any booster and could not wait to order one; so I took an ordinary transformer and connected the secondary in series with the line and the primary across the line just back of the secondary. The transformer was wound for 10-to-1 voltage, so that the secondary boosted the e.m.f. of the line a little over 100 volts (the primary voltage at the booster being about 1050). In order to cut out the booster during very light loads and get rid of the losses in the core, I connected it up to a double-throw single-pole switch, as shown in the diagram. Throwing the switch over to the right opens both the primary and secondary windings of the transformer and closes the break in the main line which is ordinarily filled by the secondary winding.



Denver, Colo. Ed S. Morgan.

Electrical Catechism

555. *How much current is required to melt a wire?*

When the wires are open to the air and when long enough so that the cooling effect of the terminals does not extend to near the middle of the wires (the fuse wires being from 2 to 12 ins. in length, according to their diameters) the currents required for melting are approximately as indicated in the following table for copper, lead and solder wires:

FUSING CURRENT IN AMPERES.

B. & S. Gauge No.	Diameter in inches.	Copper.	Lead.	½ Lead & ½ Tin.
36	.005	4	..	..
34	.006	5	..	..
32	.008	8	1	1
30	.010	11	..	..
28	.013	14	2	2
26	.016	20	3	..
24	.020	30	4	3
22	.025	42	7	5
20	.032	60	10	7
19	.036	70	11	9
18	.040	83	13	11
17	.045	100	15	13
16	.051	120	17	15
15	.057	140	20	18
14	.064	166	22	20
13	.072	200	27	24
12	.081	235	33	30
11	.091	280	38	35
10	.101	335	44	41
9	.114	390	51	48
8	.129	450	62	58
7	.144	520	77	73

The above figures are calculated from a law discovered by Preece, that the diameter (in inches) of a copper wire equals the cube root of the square of the quotient of the melting current in amperes divided by 10,244. For lead, the divisor is 1379. For the half-and-half solder, lead and tin, the divisor is 1318. The figures for lead and for solder agree closely with results of experiments by Bathurst. Part of the figures for copper fuses have been tested experimentally and found closely correct.

556. *What is a fuse block?*

A fuse block is a device for holding a fuse. It usually consists of brass clamps mounted on porcelain. Generally a porcelain or mica cover is provided, both for the purpose of preventing the fuse from flying when melting, or "blowing," and also to improve its looks, and to reduce the amount of "live" surface exposed to accidental contact. Fuse blocks are made in many different styles and for many different situations. For use on high potential circuits, such as the primary lines of 1000 volt or higher pressure circuits, and often for 100-volt circuits, the fuse is commonly placed in a separate cover piece, so that the fuse wire can be clamped in place in the cover before being connected with the live wires.

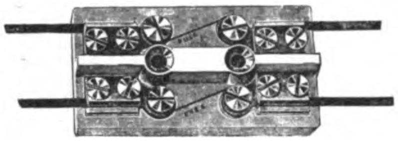


FIG. 1 — MAIN CUT-OUT.

557. *What are the principal kinds of fuse blocks?*

There is a great variety to suit various purposes. For use in electric light and power circuits, fuse blocks or "cutouts" may be classified into "mainline cutouts" and "branch blocks." A branch block is used for connecting branches to a larger circuit, the fuses being so arranged that if trouble occurs on the branch it is cut off without opening the main line. As its name indicates, a mainline cutout is placed in the main line. Figs. 1 and 2 show common forms of main and branch blocks for use on circuits for electric light or power inside buildings. Fuse blocks for use out of doors are made weatherproof, being encased in cast-iron boxes. For circuits using very small currents, such as telephones, special forms of fuse are employed.

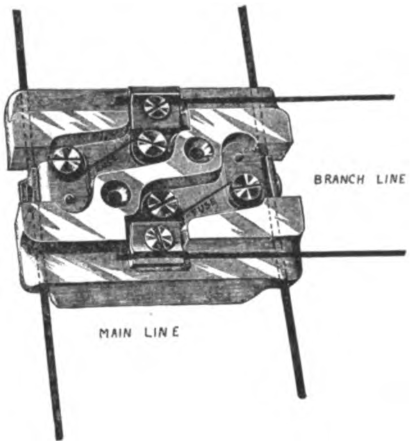


FIG. 2.

558. *What is an enclosed fuse?*

In an enclosed fuse the fusible wire is placed in a tube or in a cavity within porcelain or some other insulating substance. The space around the fuse wire is sometimes filled with some substance that will prevent the formation of an arc after the melting of the fuse. One style, shown in Fig. 3 has the fuse wire surrounded by a chemical substance, such as borax or sal ammoniac, that unites with the fuse wire and by forming a non-conducting substance destroys the conductivity of the fuse in case its temperature rises above a specified degree. Sometimes a fine fuse is spread outside the tube so as to melt after the main fuse inside and thus indicate whether it has melted. In others, such as the Edison fuse plug, the fuse wire is encased in a glass or porcelain cup from which air draughts are excluded by the cover. Enclosed fuses are more reliable than the older open fuses because the fuse wire is under practically the same conditions at all times and will therefore melt at a more definite temperature; they are coming into extended use.

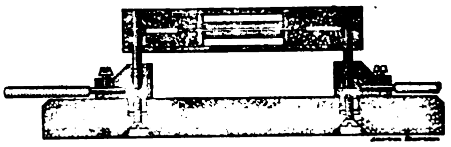


FIG. 3.—ENCLOSED FUSE.

559. *What is a protected fuse?*

Some manufacturers make fuse blocks in which the fuse is enclosed in a porcelain tube or channel having a small aperture through which the vapors following the melting fuse can escape, the arc being blown out. The tube protects the fuse from air draughts and from contact with other substances and also fixes it at a definite length. In the protected fuses the fuse wire is generally in a piece separate from the rest of the block, so that the fuse may be renewed while the cover or plug piece is entirely detached from the circuit, thus making them safer to handle than the ordinary open fuse block.

560. *What is a detachable fuse?*

The fuse terminals of a detachable fuse block are attached to the cover piece, that is, to a piece which may be removed from the stationary block so that the fusible portion may be placed in the cover or "pocket" while entirely disconnected from the circuit, the connections being made when the cover is placed in position on the base. See Fig. 4.

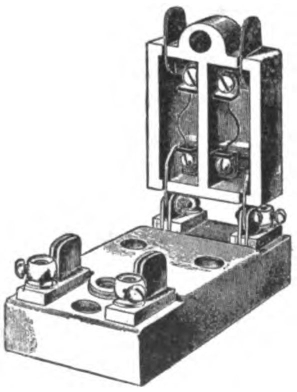


FIG. 4.

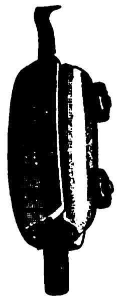


FIG 5.

561. *What is a "bug" cutout?*

Bug cutouts are small single-pole cutouts for placing in cramped and awkward places, such as in fixtures, where a regular fuse block is impracticable. (Fig. 5.)

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

What is the latest calorific value accredited to carbon completely burned? T. S. M.

14,600 B. T. U. per pound.

Would the underwriters approve using No. 18 annunciator wire to connect sixteen 3-c.p. lamps in series on a 220-volt circuit? R. L. T.

Most assuredly not.

Is there any way of preventing the needle of a steam gauge from quivering in accord with the strokes of the engine supplied from the same boiler, except by nearly closing the small cock in the gauge syphon? W. J. C.

None that we know of.

I connected the secondary of a battery-excited induction coil to the primary of another, but got no current from the secondary of the second coil. Why was this? I. B.

Because the resistance of the first secondary winding is entirely too high to pass sufficient current to excite the primary of the second induction coil.

Is a double-pole single-break switch preferable to a single-pole double-break switch? If so, why? W. T. S.

Yes; because the double-pole switch leaves the apparatus entirely dead when the switch is open, while the single-pole switch leaves one terminal of the apparatus still connected to one side of the circuit.

What is the difference between a plug valve and a piston valve in steam-engine work? G. H. C.

A piston valve may or may not be a plug valve according to its construction. If it is hollow in the center it is not a plug valve. On the other hand, a plug valve may be either a piston valve, reciprocating parallel with its longitudinal axis, or it may be a rocking valve, reciprocating circularly about that axis.

What is the best way to supply a lamp in a telephone booth during the day when incandescent service is not obtainable? During the night the lamp is supplied from an ordinary 110-volt incandescent circuit. The door is provided with an automatic switch which cuts out the lamp when the booth is not in use. F. M. A.

Change the lamp which is now in the booth to a 95-volt 50-c.p. lamp, and connect it in series with seven small storage cells during the night. During the day, disconnect the storage cells from the circuit and use them to light a 12 or 14-volt 8-c.p. lamp.

Why is the iron loss in a transformer reduced by putting more turns in the winding; is not the flux greater? Adding more turns gives a greater exciting force and produces more flux. W. F. G.

In a transformer used on a constant-potential circuit adding more turns does not increase the exciting force; the magnetizing force is reduced by a greater number of turns. The amount of flux necessary to produce the requisite counter e.m.f. is less; therefore, the core loss is less. If the transformer were on a constant-current circuit then the flux and the core loss would be greater with a greater number of turns in the winding.

About what pressure is carried in the boiler of a steam automobile? (2). About how long does it take to get up a full head of steam, starting with cold water? C. H. H.

Two hundred pounds. (2) From 10 to 20 minutes, according to the type of boiler.

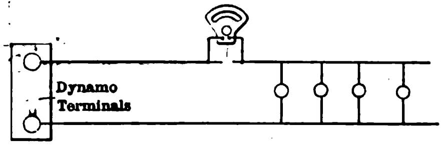
What is the difference between a hydrocarbon engine and a kerosene-oil engine? J. W. E.

None; the term hydrocarbon merely means that the fuel used is composed of hydrogen and carbon. Both kerosene and gasoline come under the head of hydrocarbons.

What is meant by "cycle" in alternating-current work? E. H.

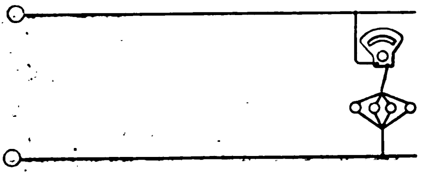
A cycle is two alternations of the current or e.m.f. as the case may be—that is to say, starting from zero the e.m.f. and current rise to a maximum in one direction, then fall to zero again, then rise to a maximum in the opposite direction and come back to zero; this is one cycle.

If a voltmeter be connected in series with an incandescent lamp circuit like an ammeter, as shown by the accompanying sketch,



will not the whole current pass through it and burn out the coils? 2. Will the lamps light? W. T. K.

Not if the voltmeter is built for a voltage equal to or above that of the dynamo which supplies the circuit. Such a connection simply means connecting the voltmeter across the terminals of the dynamo in series with the group of lamps, as shown in the second diagram. The current through the voltmeter coils will be less than if it were connected directly across from wire to wire of the circuit. If the voltmeter be designed for an e.m.f. much lower than the circuit e.m.f., however, it will be burned out, just as it would if connected across the line in the ordinary manner. 2. No.



Is more power required to raise a body of water to a given height than the same body of water would develop in falling from that height? If so, what makes the difference? C. E. S.

Assuming that the rates of raising and falling are the same, more power is required to raise a body of water than that body develops in falling, on account of the friction which has to be overcome in raising it, and the friction loss which is suffered by the falling water. If the element of friction could be entirely ignored the power would be precisely the same in both cases.

How can a series-wound booster dynamo be connected up so that it lowers the voltage instead of raising it? A. J. W.

Reverse either the terminals of the field winding or the connections between the brushes and the circuit, continuing to drive the armature in the same direction as before. If the field terminals are reversed, the result will be a reversal of the polarity of the field magnet, which will cause the voltage to oppose the e.m.f. of the circuit. If the armature terminals are reversed, the polarity of the brushes will continue the same as before, but their effect upon the external circuit obviously will be reversed.

How can two-phase currents be transmitted over three wires? (2). Is a special winding required on the generator, or some transformer? (3). In which of the three wires must a wattmeter be connected? H. A. G.

Combine two of the wires from the two phases into one wire of 1½ times the cross-section of each of the other two. (2). The generator armature must have a separate winding for each phase, or else transformers must be interposed between the four leads from the generator and the three legs of the circuit. (3). The series winding of the wattmeter should be inserted in one of the outside wires of the three-wire feeder, and the potential coil connected across from the large middle wire to one of the outer wires. The wattmeter will indicate only the energy supplied to one side of the circuit, however; if the two sides are absolutely balanced, multiply the readings of the wattmeter by 2.

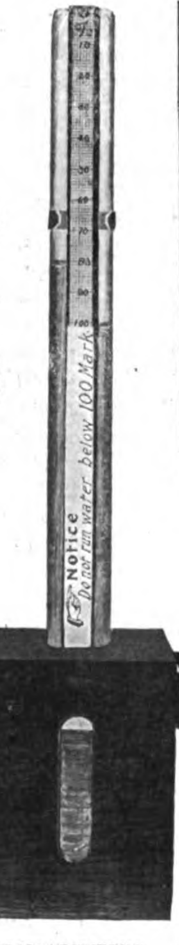
What is the difference between integrating and recording wattmeters? (2) When a differentially-wound booster helps a storage battery to discharge does it help the battery or does the booster cease to generate? If the latter, why is the booster not cut out of circuit during the discharge? J. C.

These terms are used interchangeably, but strictly there is a difference. A recording wattmeter integrates the energy passed through it with respect to the length of time of the service. An integrating wattmeter may be a recording wattmeter or simply an instrument to indicate variations in power.

(2.) When a differentially-wound booster is used in connection with a storage battery it merely interposes more or less counter e.m.f. in the storage-battery circuit, according to the conditions of the load. If the condition is such that the load is heavy then the counter e.m.f. of the booster is lowered so that the batteries can discharge and help out the generators; as the load becomes lighter the counter e.m.f. of the booster increases, reducing the discharge of the batteries, and when the load falls below the comfortable capacity of the generators the booster does not give any counter e.m.f. and allows the dynamos to charge the batteries. The booster cannot be cut out of circuit because the automatic regulation just mentioned would be annulled if it were thrown out; moreover, this would require personal attendance, whereas with the use of a properly designed booster no attendance is necessary.

BRYAN-MARSH COMPARIMETER.

One of the most ingenious uses to which the electrolytic action of current upon water has been put is found in a little instrument manufactured by the Bryan-Marsh Company, of New York City, for the purpose of testing the economy of incandescent lamps. The instrument consists of two glass tubes mounted side by side in the stopper of a vial containing slightly acidulated water. The open ends are carried down almost to the bottom of the vial, so as to be always below the level of the water; the upper ends are closed. Two lamp sockets are mounted on the sides of the box containing the vial, as shown in the cut, and these sockets are connected in parallel by wires which lead through glass tubes, the wire for the left-hand socket passing through the left-hand tube and the one for the right-hand socket passing through the right-hand tube. The lamps to be compared must of course be of the same candle-power and voltage as the two sockets are connected in parallel across the circuit from which the testing current is taken. Before turning on the current the instrument is turned upside down so that the water fills both of the tubes, then it is righted and the current turned on. The passage of current through the water in the tubes liberates gas which rises in the tubes and forces down the liquid against the external atmospheric pressure, which had previously held it up. The amount of gas liberated is proportional to the amount of current passing; consequently, the water in the tube corresponding to the lamp which takes the most current will be forced downward more rapidly than that in the other tube. A scale, graduated from zero to 100, is provided, as shown in the engraving, and this forms the means for a direct comparison of the efficiencies of the two lamps. The current is kept on until the level of the water which is falling most rapidly almost reaches 100, when the lamps are switched off and the additional gas liberated will bring the level down to 100. Then the level of the water in the other tube is noted. If the level is 98, for example, it shows that the lamp on that side takes 98 per cent of the current taken by the other lamp. One of the evident advantages of the instrument is that fluctuations of the e.m.f. of the circuit supplying the testing current do not vitiate the results of the test.



COMPARIMETER.

THE C & C SERIES-PARALLEL SYSTEM OF CONTROL FOR PRINTING-PRESS MOTORS.

The peculiar requirements of printing-press electric-motor service and the difficulties of providing accurate speed control through abnormally wide ranges of speed are too well known to need reparticularization here. In order to meet these requirements and provide the degree of control demanded, the C & C Electric Company has perfected what is termed a "series-parallel" method of control for printing-press motors. This consists broadly in providing the armature of the motor with two distinct windings and commutators which may be connected either in series or in parallel; providing compound field windings, the series coils of which are cut in and out of circuit; and effecting various combinations of these parts with the controlling apparatus, which is partly operated by hand and partly by automatic devices.

Fig. 1 is a view of the motor, which is a multipolar machine of usual construction except for the features mentioned above. Fig. 2 represents the controller lever, which is provided with a quadrant and spring latch to lock the controller handle in the various running positions. The lower end of the controller handle is connected with the controller itself by means of a rod or link; and the controller, shown by Fig. 3, is a combined field and armature rheostat, provided also with additional contacts which close circuits through two sets of solenoids actuating what are known as the "on-and-off" switch and the "series-parallel" switch. The function of the on-and-off switch, as its name indicates, is simply to open and

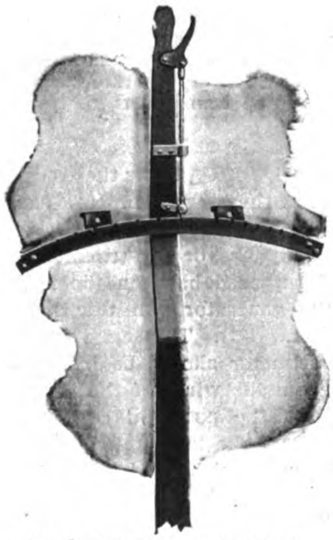


FIG. 2.—CONTROLLER LEVER

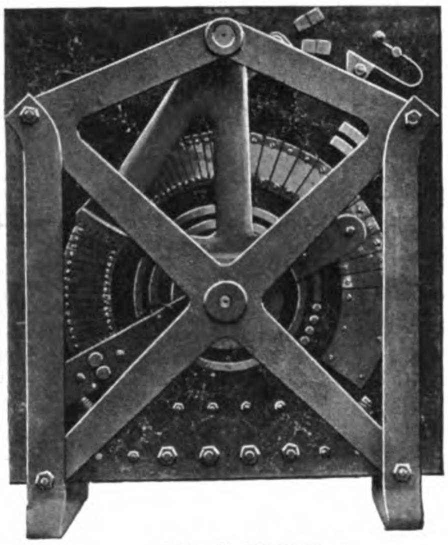


FIG. 3.—RHEOSTAT.

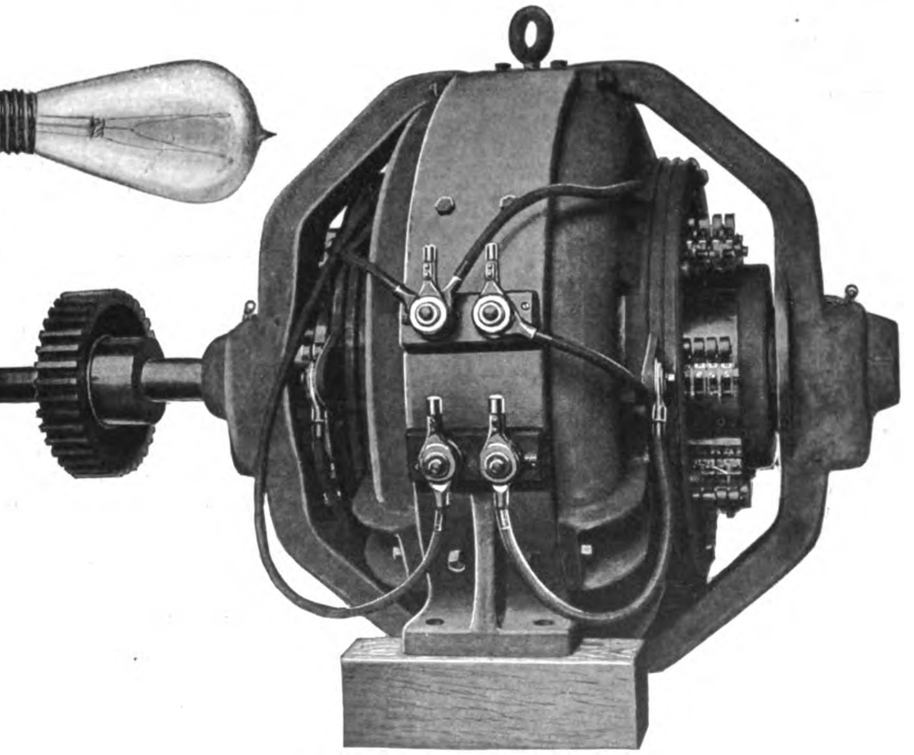


FIG. 1.—DOUBLE-COMMUTATOR MOTOR FOR PRINTING-PRESS SERVICE.

close the main circuit of the motor, and thus prevent the arcing and burning which would take place at the traveling contact finger of the rheostat. The series-parallel switch throws the two armature windings in series or in parallel according to the position of the controller, one solenoid throwing the switch in one direction and the other throwing it in the opposite direction. The controller connections are such that at the instant when the series-parallel switch operates to throw the armature windings from series into parallel, a small amount of resistance is interposed in the armature circuit to prevent too sudden an increase in speed. The on-and-off switch can also be thrown to break the motor circuit and stop the motor by pressing any one of several emergency buttons which are provided at different points. The apparatus is so arranged that when the machinery is stopped by pressing an emergency push the motor cannot be started again until the controller lever has been thrown back to the starting position. Four emergency pushes of the floor type are ordinarily supplied, and one on a wall panel near the press.

The principal regulation is obtained by cutting in and out the series field coils and changing the two armature windings from series to parallel and vice versa. As intimated above, there is also a resistance in the shunt field circuit of the motor which gives from 5 to 10 per cent increase above the normal working speed of the press. This resistance, however, is what might be termed an "emergency device" for obtaining higher speeds at each control point in the case of a rush.

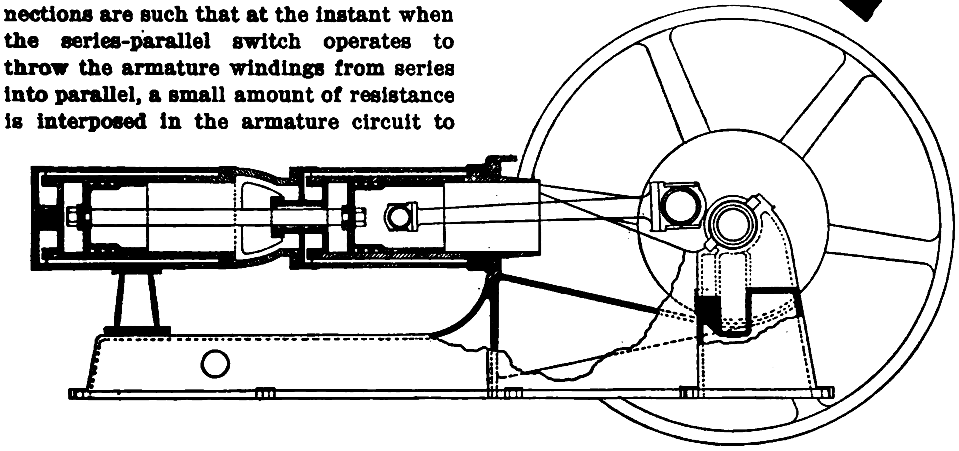


FIG. 1.—SECTIONAL VIEW OF ENGINE

◆

THE "MODERN" GAS ENGINE.

The Modern Gas Engine Company, of Buffalo, N. Y., is manufacturing a line of very compact double-cylinder engines, one of which (a 30-h.p. engine) is shown in perspective by Fig. 2, and in section by Fig. 1. In ordinary single-cylinder engines of the four-cycle type, only one explosion for each two complete revolutions can be obtained. In the engine here shown, an impulse on the crank is obtained at every revolution, the cylinders acting alternately. The arrangement of the cylinders in tandem obviously simplifies the construction and reduces the weight of the engine as compared with double-crank construction.

The bearings are self-oiling; the connecting rod is made of forged steel and provided with removable babbitt linings, which construction, it is stated, has been found to be more satisfactory than the strap arrangement. One of the most important features of construction is the arrangement of the piston rod connecting the two plungers. The rod passes through a stuffing box, of course, and this stuffing box is thoroughly water-jacket[illegible] the piston rod is made of forged s[illegible]nd in order to prevent the rod from cutting the packing in the stuffing box, a cast-metal sleeve is provided, extending from piston to piston, and completely enclosing the piston rod.

Regulation is effected by throttling the charge, which, as is well known, gives more uniform rotation than the hit-and-miss method. The ignition is electrical; the igniters are built up on small cast-iron plugs, which are inserted in the wall of the respective inlet-valve chambers, and held in place by two studs.

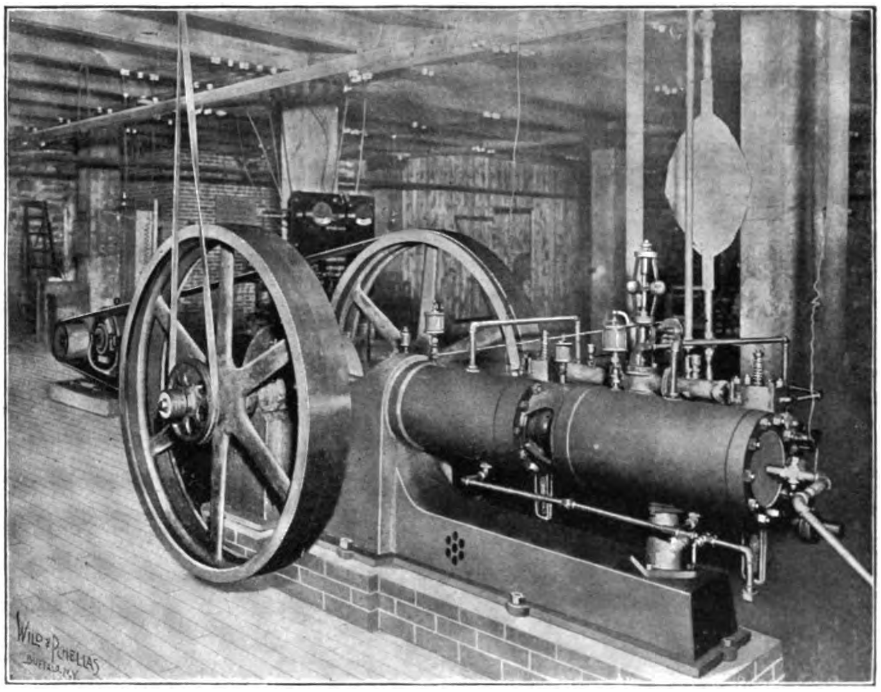


FIG. 2.—A 30-H P. "MODERN" GAS ENGINE.

The builders call particular attention to the fact that the platinum points of the igniters are kept cool by being located in the inlet chambers instead of in the cylinders, as they are directly in the path of the fresh charges of cold air and gas. The company is giving special attention to the design of these engines for electric-light work, and supplies the engines adapted either for direct connection or belt driving. Complete electric-lighting outfits are built for 40, 50, 60, 80 and 100 lights capacity.

◆

AUTOMATIC PLATING MACHINE [illegible]R ARC-CARBONS.

A new machine for automatically and continuously plating arc-light carbons which was installed last fall by the United States Carbon Company is a most ingenious piece of special mechanism. The principle of the machine is simplicity itself. The carbons to be plated are deposited in large quantities in a hopper from which they are taken by a revolving drum and automatically fed to 3000 individual holders carried on a continuous chain belt. The holders, in circuit with the plating current, carry the carbons for a distance of 175 ft. through 14 plating tanks, passing from one tank to the next over large idler wheels. After passing through the plating tanks the carbons pass through three tanks containing hot water, for boiling out the copper salts and fixing the color of the copper coating.

The endless belt carrying the carbons then returns overhead through the drying chambers, and after being registered on a mechanical counter the carbons are automatically discharged from the holders onto a conveyor which carries them a distance of 50 ft. to the packing room. This machine has a capacity of 120,000 carbons a day. Among the electrically-operated labor-saving devices used in connection with this machine is a small double-trolley motor car, for lifting and moving any one of the large plating tanks when it becomes necessary to clean it out.

New Apparatus and Appliances

G. I. ENCLOSED ARC LAMPS FOR SERIES ALTERNATING CURRENT CIRCUITS.

Figs. 1 and 2 illustrate the principal features of a series of alternating-current arc lighting system developed by the General Incandescent Arc Light Company, of New York. The lamps are intended to operate in series groups on constant-potential circuits and are of the enclosed-arc type; the difference of potential required at the terminals of a series of lamps is 80 volts per lamp. The feed-regulating solenoids are in shunt with the arc and control the feed through a Ω-shaped laminated armature and clutch applied directly to the carbon. As there are no windings in series with the arc, the voltage at the lamp hanger is practically identical with that across the arc, namely, 72 volts. These lamps are connected in series with a regulator, which operates to maintain constant current through the group; the allowance of 80 volts per lamp is to include the drop in the regulator.

The latter consists of a pair of coils into which the legs of a laminated U-shaped core are drawn by the current circulating in the coils. Two retractile springs oppose the attraction of the solenoids. It is evident that the farther the cores are drawn into the coils, the greater will be the reactance of the latter; when the current exceeds the amount for which the springs are adjusted, the coils pull the cores in until their reactance is increased sufficiently to cut down the current flow to the proper value. The standard size of regulator is designed for use in series with 25 lamps; for circuits of over 25 lamps, two or more regulators (according to the number of lamps) are used in series. This practice is preferred over the use of larger regulators, because of the better ventilation and lesser strain on the insulation of several small windings, as compared with a single large one.

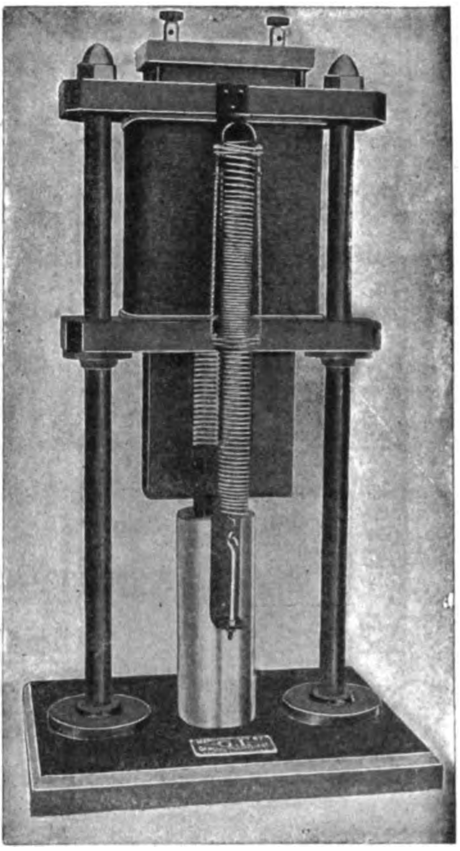


FIG. 2—REGULATOR FOR SERIES GROUPS.

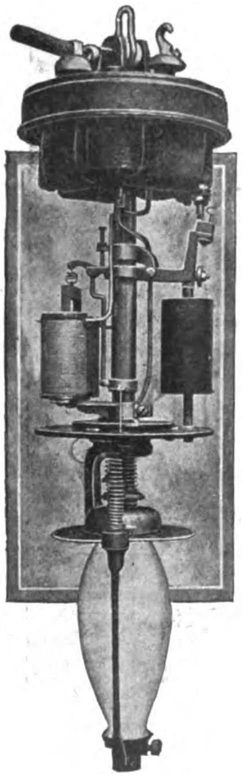


FIG. 1.—G. I LAMP.

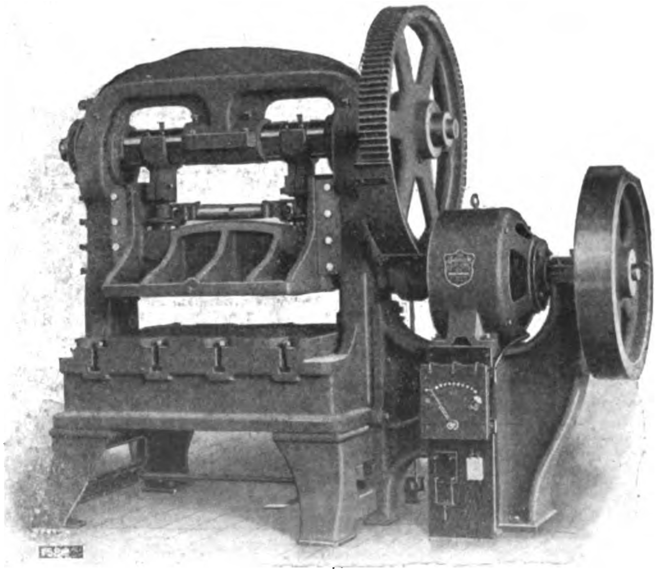


FIG. 3.—BULLOCK MOTOR DRIVING A BLANKING PRESS.

BULLOCK MACHINE TOOL MOTOR.

The Bullock Electric Manufacturing Company, Cincinnati, Ohio, is manufacturing a special type of motor, known as "Type N," and designed particularly for driving machine tools. The motor is a multipolar machine with a circular cast-steel yoke and laminated sheet steel magnet cores bolted to the yoke. The magnet core punchings have half pole-shoes, and in assembling the cores the punchings are alternated, so that while the complete core shows a pole-shoe on each side, the thickness of the pole-shoe parallel with the armature shaft is only one-half the thickness of the magnet core. The result is that the pole-face is magnetically saturated, conducing to sparkless operation. The magnet coils are machine wound and insulated before being placed on the magnet poles. The armature core discs are annealed and japanned before assembling. The armature winding consists of formed coils of the usual type, insulated before being placed on the core, and held in the slots by wedges of hard wood. The machine is furnished either semi-enclosed or completely enclosed, according to the conditions under which it is to work. Fig. 3 shows one of these motors geared to a stamping press. For this class of service, where the load comes in the shape of a sudden shock at intervals, the motor is provided with a heavy fly-wheel, which takes the brunt of the shock. These machines are built in sizes ranging from ⅛ to 35 horse-power at 300 r.p.m.; 1 horse-power to 70 horse-power at 600 r.p.m.; 1½ horse-power to 100 horse-power at 900 r.p.m., 2 horse-power to 25 horse-power at 1200 r.p.m. These ratings are for motors with ventilating openings in the end plates, as shown in the illustration; when the motor is completely enclosed its rating is lower, of course.

PRINGLE PORCELAIN PLUG AND FLUSH RECEPTACLE.

W. T. Pringle, of Philadelphia, has brought out a new form of plug and receptacle for incandescent-lighting service, which are illustrated by Fig. 4, below. The illustrations are practically self-explanatory. The plug is of high-grade nonabsorbent porcelain, carrying flat contact strips on the two edges furthest removed from each other, and is provided with the usual facilities for fusing. The handle, or part of the plug which is exposed when it is in the receptacle, is handsomely finished in dead black to resemble hard rubber. The receptacle has a cover which entirely encloses the socket when the plug is withdrawn, leaving a smooth continuous metal surface exposed. The connections are made from the front, thus obviating the objection of having to push a lot of slack wire

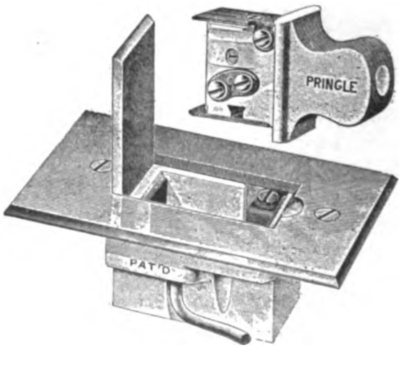


FIG. 4.—PRINGLE PLUG AND RECEPTACLE.

back into the wall. The depth of the porcelain is less than 1½ ins., so that the receptacle may be used in comparatively thin partition walls. The face plate need not be put on until the wiring is finished.

L-H ENCLOSED-ARC LAMPS.

Figs. 5 to 7, inclusive, represent the direct-current enclosed-arc lamp made by the Lea-Hooven Manufacturing Company, of Anderson, Ind. The mechanism of the lamp is very clearly shown by Fig. 6; the clutch, which is a modification of the Brush type, is actuated by a double solenoid, the movement of the armature being suitably damped by a dash-pot. The dash-pot cylinder is provided with two steel ball valves and the plunger is of fiber graphite. This construction is said to obviate the flickering which is so often seen when an arc is first struck, and to render the mechanism free from irregular action due to expansion of a dash-pot plunger. Connection between the upper carbon and the stationary part of the mechanism is not effected by means of a sliding contact, but by a flexible cord from the upper end of the carbon to one solenoid terminal. The resistance wire is wound on a core consisting of a piece of flattened bicycle tubing having a grooved strip of vitrified porcelain on each edge, as shown by Fig. 5. The wire, therefore, cannot sag under the influence of its own heat and cause short-circuits between convolutions. Fig. 7 illustrates the readiness with which access is had to the inner globe and carbons. The lamp measures 22 ins. in length, over all, when fitted with a globe, and 21 ins. when fitted with a shade.

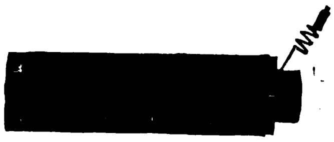


FIG. 5.—RESISTANCE COIL.

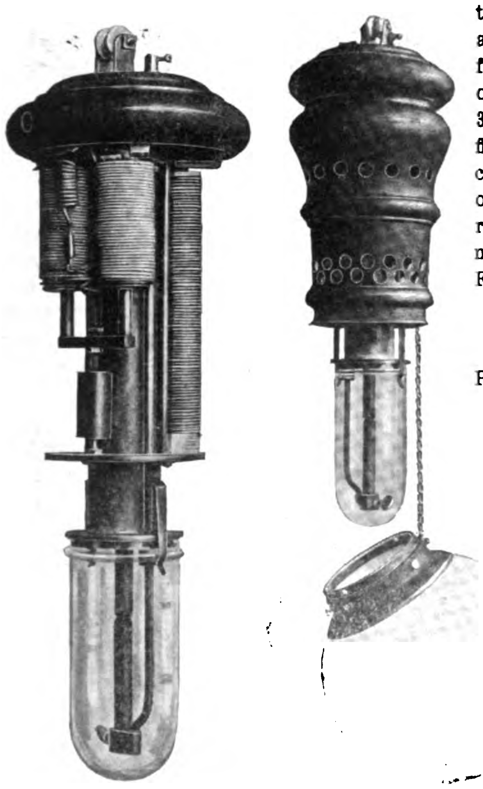


FIG. 6.—LEA-HOOVEN ENCLOSED ARC LAMP —FIG. 7.

THE FRANKLIN DYNAMO.

Parsell & Weed, of New York City, are supplying the parts for an interesting little machine, designed for amateur construction. Fig. 8 shows the machine complete. The field magnet is made up of laminations and is of the horseshoe type. The design of the machine is very similar to the small bipolar Perret motor. The yoke of the field magnet is made up of alternate long and short strips, in order that the laminations may completely fill the space bounded by the outline of the yoke cross-section. The armature core is of the slotted type having eight slots for armature coils. When used as a motor, this little machine will drive a sewing-machine, a dental engine or a watch-maker's lathe. The winding is designed for battery current with 10 volts e.m.f. at the terminals of the machine. When run as a dynamo the machine will maintain four 2-c.p. lamps. The complete machine occupies a space of 3½ ins. x 6½ ins., is 3½ ins. high and weighs 5¼ lbs. The firm supplies the parts in various stages of completion; they are supplied in the rough or partly finished, or completely finished ready for assembling and winding; the machine is also supplied completely built. Full instructions go with each set of parts.

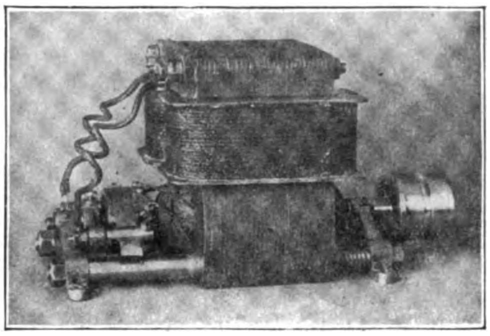


FIG. 8.—FRANKLIN DYNAMO.

P. P. P. ROD PACKING.

The Quaker City Rubber Company, Philadelphia, Pa., calls attention to a peculiarly elastic form of rod packing which is illustrated by Figs. 9 and 10. The packing consists of two strips each of triangular cross section surmounted by an approximately semi-circular cross section of eleven strands, as shown in Fig. 9. The object of the triangular sections is to obtain a positive mechanical spreading when pressure is applied to the packing; an inspection of Fig. 10, which shows the packing in a stuffing box, will render this clear. The semi-circular portion of the packing is compressed so as to fill the entire available space, and the triangular sections slide upon each other with the same result. The stranded portion of the packing is an absorbent cushion which holds the oil and keeps the rod lubricated. The triangular sections are made with a view to withstanding wear. The packing is said to be impervious to the action of acids, alkalies and sulphurous waters, and to remain soft and elastic throughout its life.

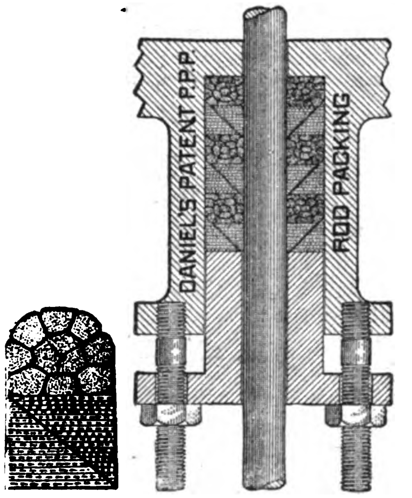


FIG. 9.—P. P. P. PACKING.—FIG. 10.

NEW ZIMDARS & HUNT FLUSH PLUG RECEPTACLE.

Figs. 11 and 12 illustrate the latest form of flush receptacle and plug brought out by Zimdars & Hunt, of New York City. One of the principal features of the apparatus is that when the plug is in position within the receptacle there is no protruding knob to be injured by accidental blows and to mar the ornamental appearance of the face-plate of the receptacle. As the engravings plainly show, the receptacle is provided with a split cover, each half being hinged to the plate; the two halves form virtually two doors, which completely enclose the plug when it is in the receptacle. The new form of recep-

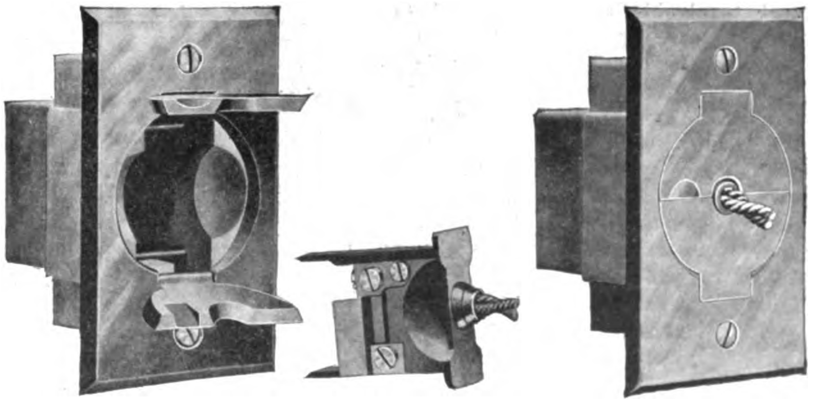
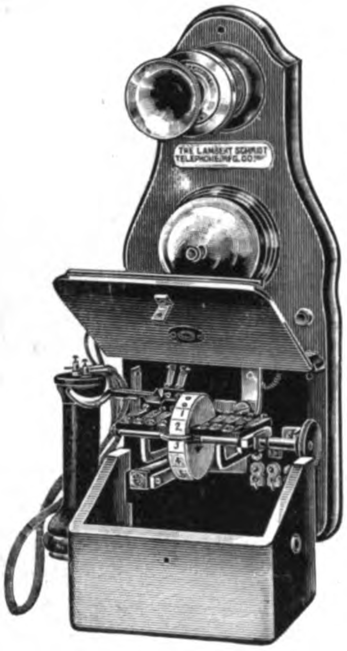


FIG. 11.—ZIMDARS & HUNT PLUG AND RECEPTACLE.—FIG. 12.

tacle is provided with binding posts at the top so that removing the face-plate enables the workman to make the wire connections easily when the receptacle is in place on the wall. The plug is provided with knife-blade contacts which fit into substantial clips in the pocket of the receptacle, and it also has fuse connections. The face-plate is supplied in polished bronze or in brass finish, as may be desired.

AUTOMATIC-RESET INTERCOMMUNICATING TELEPHONE.

The Lambert Schmidt Telephone Manufacturing Company, New York, has recently introduced an automatic-reset intercommunicating telephone outfit which is illustrated by Figs. 13 and 14. Fig. 13 illustrates the desk telephone outfit, which comprised a black-enameled base surmounted by a switching device encased in a nickel-plated cover. On the top of the cover is a metal support, forked at the ends, through the center of which passes a tube with a hard rubber piston extending upward from within the cover. The microtelephone, or combined transmitter and receiver, is connected to the stand by a flexible cord and lies horizontally in the forked supports. The selective switch consists of a series of metal pins projecting at different angles from a central revolvable steel shaft, and arranged to make wiping contact with stationary springs mounted on each side of the shaft and connected with the various stations of the system. The spindle of this switch is normally held at the home position by a spring witnin the box and carries a ratchet wheel having a number of teeth corresponding with the number of stations, and consequently, the number of positions to which the switch may be turned. A pawl is so arranged that when the microtelephone is removed from its support the piston beneath the center of the handle is allowed to rise and bring the pawl into engagement with the ratchet wheel, so as to hold the selective switch in the position to which it has been turned before the telephone was removed from its support when the conversation is finished and the telephone replaced it presses down the rubber piston and releases the ratchet wheel, allowing the spring to return the switch spindle to the home position. The spindle also carries an aluminum wheel bearing the numbers of the stations, as shown in Fig. 13. When the cover is in place these numbers come opposite a little window in the top of the box so that the position of the selective switch is indicated through this window. The procedure in calling up is as follows: The microtelephone is first removed from its support and the switch is revolved by means of the knob at the side of the box until the number of the station wanted appears at the window on top. Then that station is rung up by means of a push button, not shown in the engravings. Taking the telephone off its support allows the pawl to engage with the ratchet wheel, as mentioned above, so that the switch remains at the point to which it was turned, until the telephone is replaced on the hooks. The system requires one individual wire for each station and two common wires running through all of the stations. A common battery is used for ringing, but local batteries are required for the transmitters. This arrangement is also applied to wall telephones, as indicated by Fig. 14. The construction is precisely the same except that the ordinary form of transmitter and receiver are used, the latter being hung on a receiver hook of the usual form.


THE LAMBERT SCHMIDT TELEPHONE MFG. CO.

FG. 14.—AUTOMATIC-RESET WALL OUTFIT.

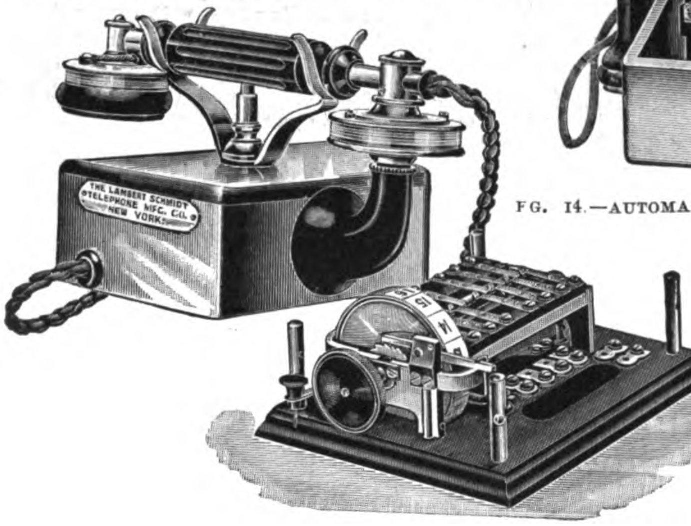

THE LAMBERT SCHMIDT TELEPHONE MFG. CO. NEW YORK

FIG. 13.—AUTOMATIC-RESET DESK OUTFIT.

RICHMONDT ELECTRO-GALVANIZED CONDUIT.

One of the principal difficulties encountered in installing wiring in conduits is the abrasion of the insulation by rough surfaces within the conduit in the course of drawing in the wire. With a view to eliminating this trouble, the Richmondt Electric Wire Conduit Company, Milwaukee, Wis., has brought out what it calls an electro-galvanized wire conduit tubing, the principal feature of which is the provision of a uniformly smooth surface on the interior wall of the conduit pipe. This is obtained by applying a coating of enamel to the wall throughout the length of the tube. The conduit tube is reamed in order to obtain an absolutely uniform size and it is then completely galvanized, including the threads, after which the enamel is applied to the interior wall. The couplings are also galvanized. Another feature which contributes to the ease of drawing in the wire is a slight flaring of the end of each section of conduit, as indicated in Fig. 15. This of course removes the sharp edge at the end of the pipe and prevents liability to abrasion of insulation at that point.

FIG 15.—ELECTRO-GALVANIZED CONDUIT

CLIMAX STEAM JOINT CLAMP.

Fig. 16 represents a Climax pipe joint clamp which is made by James McCrea & Co., of Chicago, for large pipes of say 10 ins. diameter and over. Referring to the engraving, the section marked A is a rigid clamp held tightly to the pipe by set screws. The middle section, B, is a loose collar, the function of which is to compress the packing, 1, which lines the interior of the collar, C. This latter collar is put around the pipe next to the joint and the clamp, A, is then set up tightly on

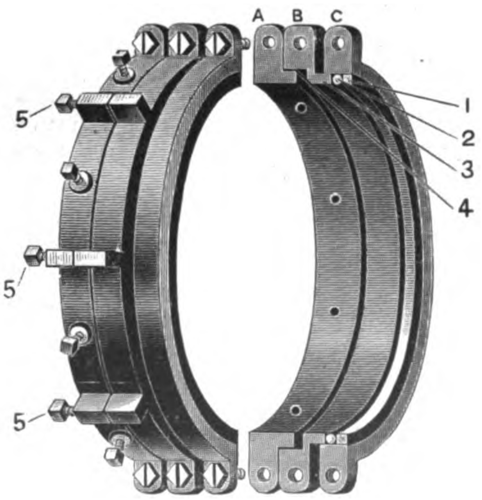


FIG. 16.—CLIMAX STEAM JOINT CLAMP.

the pipe. The set screws, 5, are then set up, forcing the loose ring, B, over toward the ring, C, and compressing the packing ring, 1, against the shoulder of the joint through the medium of the follower ring, 2.

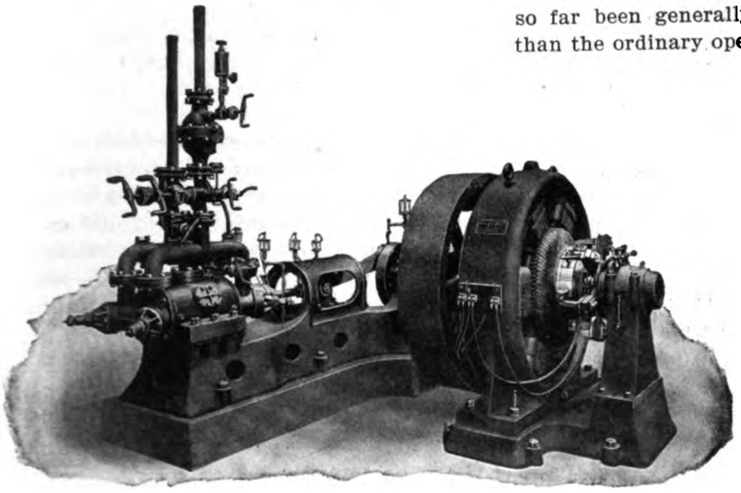


FIG. 17.—TRIUMPH REFRIGERATING OUTFIT.

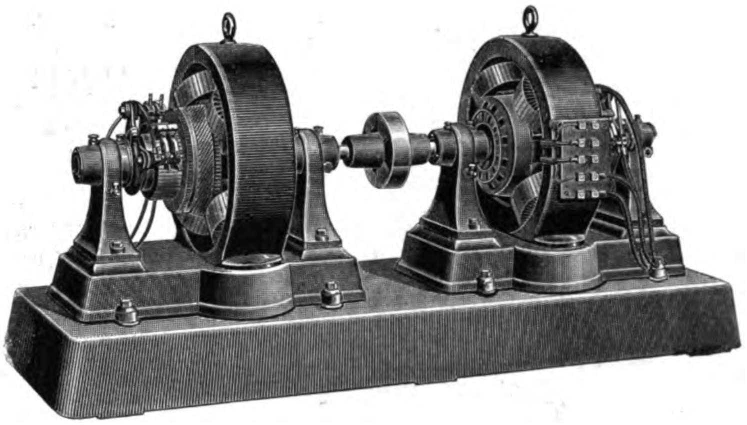


FIG. 18.—MOTOR DYNAMO FOR TELEPHONE EXCHANGES.

TRIUMPH MOTOR AND AIR COMPRESSOR.

Fig. 17 represents a compact air-compressing outfit built by the Triumph Electric Company, Cincinnati, Ohio, for the new office building of the Union Trust Company of that city. The outfit forms part of the refrigerating plant of the building. The output of the motor is 25 horse-power, but as it runs at the extremely slow speed of 75 r.p.m., the frame of a 60-kw. generator had to be used for its construction. The motor is a six-pole machine with compound field windings, the series winding being used in order to obtain high torque without excessive current when the compressor is passing the maximum points at each end of the cylinder, the ice machine being double acting. A speed of 85 r.p.m. is obtained, when desirable, by the use of a rheostat in series with the shunt-field winding of the motor. The plant is to furnish 350 gallons of ice water an hour, filtered at 38° Fahrenheit. and water is furnished to the refrigerating plant at a temperature of 85 to 90°. The plant also includes two triplex pumps belt-driven by slow-speed Triumph motors running at 600 r.p.m.; one of these pumps is used for circulating the brine and the other for delivering ice water to the distributing system, which extends throughout the seventeen stories of the building.

SEMI-ENCLOSED COMMERCIAL GENERATORS.

Enclosed and semi-enclosed dynamos and motors of small sizes have been familiar to engineers for some years past, but machines of considerable size have not so far been generally built in any other than the ordinary open form. Fig. 19 herewith illustrates the field magnet of a new type of semi-enclosed generator developed by the Commercial Electric Company, of Indianapolis, Ind., and built in sizes from 25 to 120 kw. capacity. The machine is multipolar, of course, and the feature which differentiates it from the other multipolar generators built by this company is the use of the perforated end plates, which partially inclose the field magnet cores and windings. The armature is of the usual type, having a slotted core carrying form-wound and heavily insulated coils. A complete armature and its commutator are illustrated by Fig. 20.

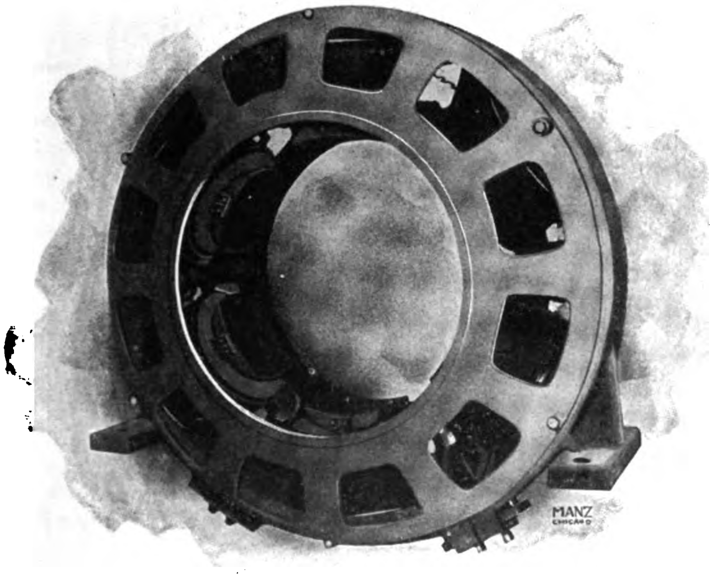


FIG. 19 —SEMI-ENCLOSED GENERATOR MAGNET

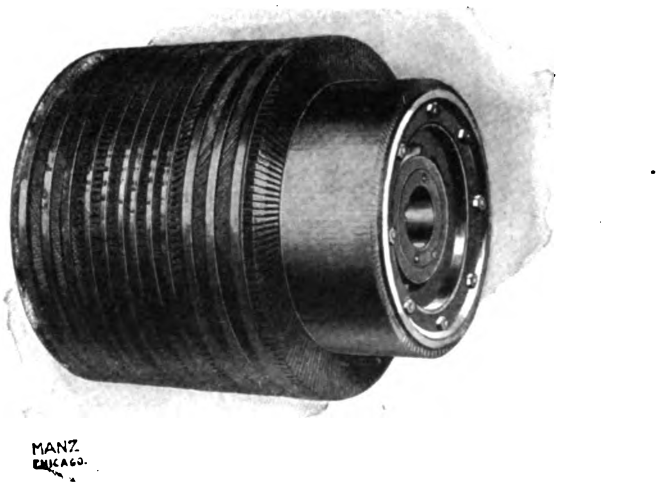


FIG. 20 THE ARMATURE.

HOLTZER-CABOT TELEPHONE EXCHANGE MOTOR-DYNAMO.

The accompanying illustration, Fig. 18, represents the latest type of motor-dynamo brought out by the Holtzer-Cabot Electric Company, Brookline, Boston, for telephone exchange service. The motor is a standard direct-current multipolar machine and drives the telephone generator through a flexible insulated coupling. The dynamo is provided with an unusually large number of armature coils and commutator segments, which feature, combined with a peculiar shape of pole-shoe, enables the machine to deliver an almost absolutely non-pulsating current. The manufacturers claim that the e.m.f. is so nearly uniform that the users of the telephone cannot tell that the current is not supplied from a battery. The dynamo may be used either for direct service or for charging storage batteries in multiple with the service mains. The outfit is built in sizes ranging from 1-kw. to 10-kw. output.

SCOTT HIGH-PRESSURE VALVE.

Fig. 21 represents a Scott gate valve built by the Roe Stephens Manufacturing Company, Detroit, Mich., for extra heavy pressures. This line was designed to fill a demand for a thoroughly durable and reliable valve to work under the heaviest steam pressures used in practice. The valves are tested to 1000 lbs. pressure per square inch. The body of the valve, as shown by the illustration, is reinforced by ribs parallel with the barrel. A peculiar internal construction is employed by means of which, it is said, all wear is removed from the face and seat, and springing of the discs is entirely prevented. The discs are raised by their lugs coming in contact with shoulders on a cylindrical wedge, and the lugs are so arranged that the bearings of one disc slightly rotate on the other; consequently, the least movement of the stem releases one disc in advance of the other, making it easy to open the valve under heavy pressure.

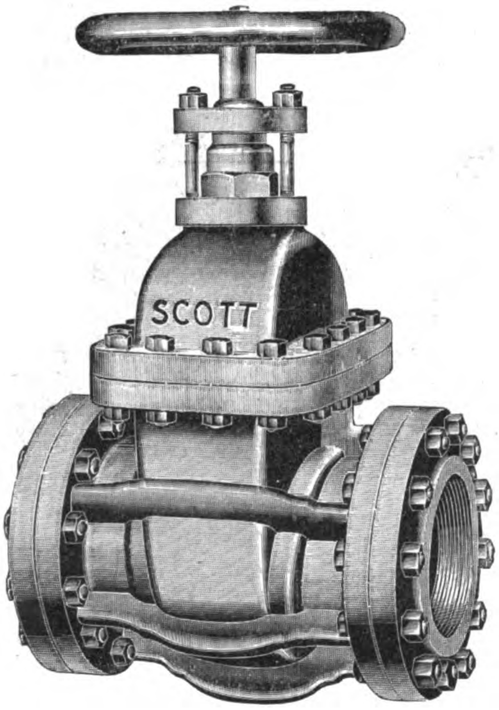


FIG 21.—SCOTT HIGH PRESSURE VALVE.

A NEW QUEEN PHOTOMETER SCREEN.

Queen & Co., Inc., of Philadelphia, Pa., have brought out a modification of their well-known Lummer-Brodhun photometer screen and sight box, which is illustrated in Fig. 22 herewith. The manufacturers state that the improvements embodied in this box enable the operator to obtain a balance, without the reversal of either the box or screen, which will be correct within 1/10 of 1 per cent on an average of 15 to 25 readings taken with the box set in all the various positions. This box is also said to be accurate on reversals within 2 millimeters on a 2500-millimeter bar; that is to say, within 8/100 of 1 per cent. When it is considered that photometer boxes are not ordinarily guaranteed within 10 millimeters on reversals, the extreme accuracy of this instrument will be appreciated. In order to keep the interior of the box clean and free from dust, the sides are fastened on with screws having milled heads, so that no tool is required to take off the sides for dusting out the box. The engraving shows the sight box mounted on a truck for use in connection with an ordinary photometer track; this truck is so arranged that it will take the regular Bunsen sight box, so that it may be used in connection with either type of box. There is also a convenient device for clamping the carriage at any desired position on the photometer bar.

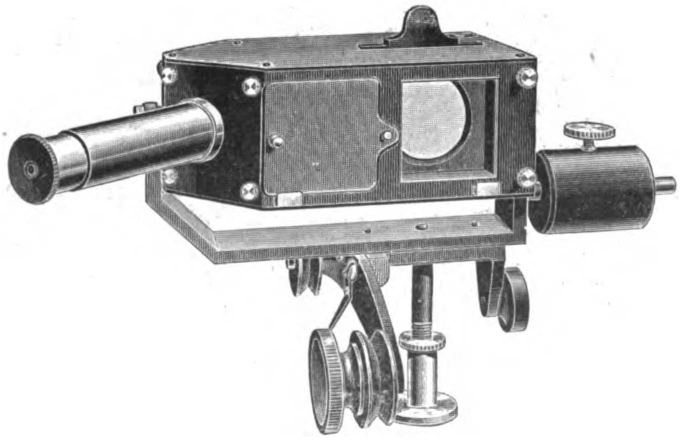


FIG. 22—PHOTOMETER SCREEN AND SIGHT BOX.

ELGIN ADJUSTABLE PIPE WRENCH.

The Elgin adjustable wrench, marketed by the Western Electric Company, is an extremely handy tool. Although the jaws are of the well-known "alligator" type, it is easily and accurately adjusted, and has a wide range of usefulness. It will hold pipe, nipples, collars, rods, and square, hexagonal or round nuts, making it useful to steam engineers, electricians, machinists and almost all other metal workers. It is nicely proportioned, well finished and fully nickel-plated; it is of steel, with hardened jaws, 7 ins. long, and weighs ten ounces. Fig. 23 illustrates the wrench and indicates clearly the method of adjustment.

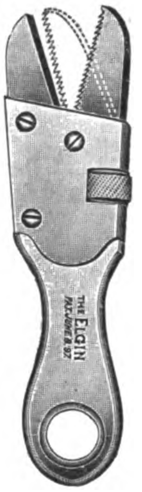


FIG. 23.

REPLOGLE RELAY-RETURNING WATER-WHEEL GOVERNOR.

Fig. 24 illustrates the latest form of Replogle water-wheel governor built by the Replogle Governor Works, Akron, Ohio. This governor is a development of the electrical relay apparatus which was formerly built by this company, but it is purely mechanical in operation. The general principle of the governor is exactly the same as that of the electrical governor, which is familiar to most readers of this paper, the chief difference being that the pawls are thrown into and out of engagement with the respective ratchet wheels by the direct action of the fly-ball governor shown at the top of the machine. This new form of governor is said to give even closer regulation than the electro-mechanical type which was its progenitor. It is built in several sizes to suit various requirements, and adapted for use in connection with all classes of water-wheels, from the ordinary turbine to the heaviest impact wheel under high heads.

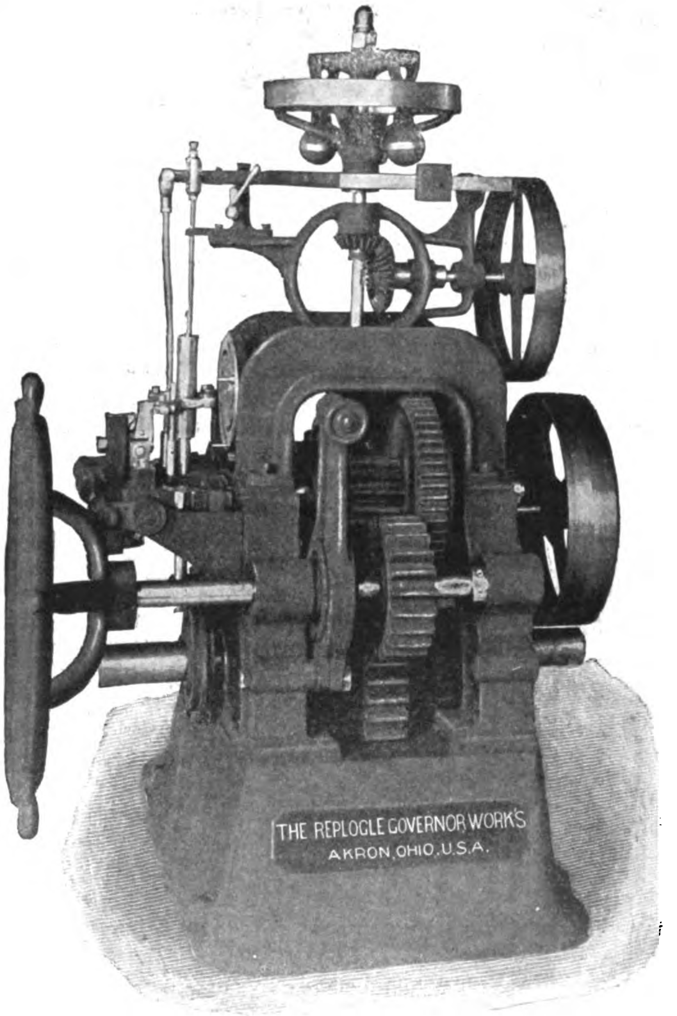


FIG. 24.—RELAY-RETURNING WATER-WHEEL GOVERNOR.

THE BUSINESS SITUATION AT THE CLOSE OF 1900.

THE BURT MANUFACTURING COMPANY, Akron, Ohio; Oil Filters.—We have had an exceedingly prosperous year and look for a good trade during 1901.

STANDARD TELEPHONE AND ELECTRIC COMPANY, Madison, Wis.; Telephones.—We have had a very successful year's business and the outlook for 1901 is good.

CENTRAL ELECTRIC COMPANY, Chicago; Electrical Supplies.—Business for the year 1900 has been satisfactory, and we regard the prospects for 1901 as encouraging.

WALSH'S SONS & CO., Newark, N. J.; Second-hand Apparatus.—Conditions during the year have been gratifying, inasmuch as during the entire period business has been quite brisk.

THE HAINES & NOYES COMPANY, Chicago; Telephones.—Our goods have sold well and our future prospects are excellent. We have many large contracts on hand and we have many others in view.

NEW YORK & OHIO COMPANY, Warren, Ohio; Incandescent Lamps and Transformers.—Our business for the past year has been very satisfactory and we believe it will remain in this condition the coming year.

MARINETTE IRON WORKS, Marinette, Wis.; Gas Engines.—Business during the past year has fully met our expectations, and we are looking forward with confidence to a good market for the coming year.

THE ECONOMY ELECTRIC COMPANY, Warren, Ohio; Renewing Incandescent Lamps.—At present our factory capacity is being taxed to the utmost to keep up with orders, which are daily increasing.

SCHUREMAN & HAYDEN, Chicago; Second-hand Apparatus.—Our business for the year 1900 has been just double that of the previous year, and from present indications the new year should be fully as prosperous.

JAMES LEFFEL & CO., Springfield, Ohio.; Turbines and Engines.—In our Samson turbine work we have done a fine business during 1900, and our future inquiries and prospects are good for the coming year.

PRISMATIC ELECTRIC SIGN COMPANY, Syracuse, N. Y.; Electric Signs.—Business conditions during the past year in our line have been extremely favorable and the future for this class of business looks very bright.

MICA MACHINE COMPANY, Pittsburg, Pa.; Mica Machines.—Business in general is the best we have ever known it to be, and prospects are still better. We expect to have all we can attend to during the coming two years.

CREST MANUFACTURING COMPANY, Cambridgeport, Mass.; Automobile Motors.—Our business has increased very rapidly up to the present time, and we consider that the outlook for business next year is exceedingly good.

THE REPLOGLE GOVERNOR WORKS, Akron, Ohio; Water Wheel Governors.—The past year's business has been the most satisfactory that we have ever experienced; so far as we can judge, the outlook for 1901 is most promising.

HUGO REISINGER, New York; "Electra" Carbons.—Business during 1900 has been exceedingly good, and in view of the enormous growth of enclosed arc lighting, a largely increased demand during the season of 1901 is expected.

I. P. FRINK, New York; Reflectors.—We have found business during the past year all we could expect and more, as the demand for our line of goods has been particularly strong, and the prospects for the coming year look very bright indeed.

THE WARREN ELECTRIC AND SPECIALTY COMPANY, Warren, Ohio; Transformers and Incandescent Lamps.—The business in transformers is greatly exceeding our most sanguine expectations, and the outlook for future business is bright.

SKINNER ENGINE COMPANY, Erie, Pa.; Steam Engines.—The business done by this company during the year 1900 has been the largest and most satisfactory in its history, and the prospects seem to indicate even better conditions for the coming year.

LEA - HOOVEN MANUFACTURING COMPANY, Anderson, Ind.; Arc Lamps.—Our business has been good, and we expect to have a much larger business in the coming year, as we are getting a great number of inquiries, especially in the far South and West.

THE HART & HEGEMAN MANUFACTURING COMPANY, Hartford, Conn.; Switches.—The volume of business and collections for the past year have been most satisfactory. We see no reason why the same conditions should not prevail during the coming year.

THE NEW PROCESS RAW HIDE COMPANY, Syracuse, N. Y.; Gears and Pinions.—Our business for the year of 1900 has been larger than that of any previous year and satisfactory in every way. We confidently anticipate the continuance of good trade for the coming year.

THE WIRT ELECTRIC COMPANY, Philadelphia, Pa.; Rheostats.—We expect to considerably increase our plant and space, after which time we shall be in a position to take care of more work, but at the present time we are obliged to work at night to keep up with orders.

NEWTON MACHINE TOOL WORKS, Philadelphia, Pa.; Machine Tools.—We have had the largest output of any year since we have been in business. We have recently received very satisfactory orders and the prospects are of the best. We have recently trebled our shop capacity.

GEORGE W. LORD, Philadelphia; Boiler Compounds.—We are particularly busy; in fact, the year 1900 has been the most prosperous we have had, but we will be very much disappointed if our business during the year 1901 does not show an increase of at least 25 per cent.

AMERICAN MINIATURE AND DECORATIVE LAMP COMPANY, New York; Incandescent Lamps.—We have done the largest business during 1900 since our existence. We anticipate a still larger business for 1901 and are about getting ready in again doubling our capacity for any emergencies.

WILMARTH & MORMAN COMPANY, Grand Rapids, Mich.; Drill Grinders.—Our sales were very much larger in 1900 than in 1899. There was a material increase in 1899. There was a material increase in the amount of export business. We do not see why there should not be a good business in 1901.

AMERICAN ENGINE COMPANY, Bound Brook, N. J.; Engines and Generators.—We have had more business than we could possibly handle, running our establishment night and day. We have just completed a large addition to our works, and we think the outlook for the coming year very encouraging.

TEXAS ARM AND PIN COMPANY, Beaumont, Texas; Cross Arms, Pins and Brackets.—The past year has proven phenomenally successful, we think we can reasonably expect to increase our sales 100 per cent. in 1901, which, in our opinion, will be the greatest construction year in the telegraph and telephone world.

THE CROUSE-HINDS ELECTRIC COMPANY, Syracuse, N. Y.; Switches.—We have had more business than we could handle during the past year, and the outlook for the coming year is most bright for a continued increase. We are so well satisfied with the prospects for 1901 that we are doubling our capacity.

DIAMOND METER COMPANY, Peoria, Ill.; Meters and Transformers.—Our business for the past year has been much better than the year before; in fact, we have had all that we can possibly do and take care of our trade, and from present indications we look for a continuance for at least some time to come.

THE SPRAGUE ELECTRIC COMPANY, New York; Dynamos, Motors and Interior Conduits.—Owing to a constantly increasing demand for its product, the Sprague Electric Company has been obliged to greatly increase the floor space in the New York office, which is now located on three floors of the factory.

GARL ELECTRIC COMPANY, Akron, Ohio; Telephones.—Business for the past year has been quite satisfactory and the prospects for 1901 are first-class. The company is just being reorganized and after this matter has been settled we are looking forward to a very busy time, being just as busy as we can be at present.

PERU ELECTRIC MANUFACTURING COMPANY, Peru, Ind.; Porcelain Goods.—Business during the past year has been very satisfactory. In order to meet the large demand for our goods we have been compelled to enlarge our factory from time to time, and are now making many changes which will increase the capacity very largely.

JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J.; Lubricants.—We can only say that we have during the entire year of 1900 been pushed to our utmost capacity to fill our orders. We have made large additions to our works, and the prospects for 1901, so far as we can see, are apparently as good as they were in 1900.

ROYAL ELECTRIC COMPANY, Peoria, Ill.; Alternators and Transformers.—Our business this year has been highly satisfactory. We have sold a greater number of generators than in any year before, and at prices that have netted us a nice profit. Our collections have been prompt and satisfactory. With our increased facilities we expect to treble the volume of our business in 1901.

ZIMDARS & HUNT, New York; Switches and Switchboards.—The past year has been satisfactory. While the period immediately preceding the election is usually one of diminished activity, there was this year little if any diminution in the volume of business handled at this time. The outlook for the coming year is decidedly encouraging.

THE HOMER COMMUTATOR COMPANY, Cleveland, Ohio; Commutator Work.—Business of the past year has proven very satisfactory to us, so much so, in fact, that we were enabled to build a new factory in which we are now located. We think there is a very bright outlook for next year's business and hope to get our share of it.

MONTAUK MULTIPHASE CABLE COMPANY, New York; Fire Detective Wire.—In our opinion, the year 1900 has been quite prosperous. Our orders have been much larger than for the previous year, being for thousands of feet instead of hundreds; one of our latest house installations required 7,500 ft. The outlook for 1901 is very promising.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo.; Motors.—Business for 1899 was good; 1900 was better, and for 1901 we look for the best showing of all. There is a generally hopeful and satisfactory feeling apparently prevading the entire business community, as reflected in that trade in which we are directly interested.

BLISS-CHESTER COMPANY, Providence, R. I.; Metal Goods and Stampings.—Our house was organized July 1, 1900, and we have had the pleasure of a very encouraging business from the start. Our contracts are now beginning to come in for the year of 1901, with every indication of a good business, taken at good prices, throughout the year.

H. M. N. MUHLE, Dayton, O.; Storage Batteries and Grids.—Business with me in the past months has been exceedingly fine. I have orders from some of the largest concerns in the country. Central station managers are realizing more every day the advantage of storage batteries, and I think there is a bright future for the storage battery business.

MACHADO & ROLLER, New York; Electrical Instruments.—In spite of continuous night-work, we are over four weeks behind on orders for our new "column" indicating and recording instruments, and although we are making prompt deliveries on our lines, it is hard work to keep up. We see no present indications of a falling off in business.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Chicago; Telephones.—Our business, as well as the independent telephone business in general, has had a continued healthy growth and has far exceeded that of any previous year. The prospects for the first year in the new century are even brighter than at any time in the past.

THE BALL & WOOD COMPANY, New York; Steam Engines.—We have found the business conditions during the year just closing on the whole very satisfactory, and have been pleased to note that the demand for our engines has been well maintained and compares very favorably with 1899. We regard the prospects for the coming year as unusually favorable.

THE STEWART HEATER COMPANY, Buffalo, N. Y.; Heaters.—We have had about all the business we could handle during the past year, and are now as busy as bees trying to fill our orders. The prospects for the coming year are good, in fact better than they have been for several years. We have orders enough now on our books to keep us hard at work for the coming month.

STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, Pa.; Wires and Cables.—We believe the business of the current calendar year in the electrical and allied lines to have been the most prosperous in the history of those industries. While we consider the outlook for 1901 to be quite good, we do not believe that business will be so large in the electrical and allied lines next year as it has been this year.

THE D. M. STEWARD MANUFACTURING COMPANY, Chattanooga, Tenn.; Lava Insulators.—The last year's business has been eminently satisfactory to us. We have had a large increase in all the lines which we manufacture, and this is true to a greater extent of lava insulators than any other line. We have some contracts on hand for delivery next year, and every indication points to a successful and profitable year.

COMSTOCK MANUFACTURING COMPANY, Comstock, Mich.; Engines.—The year 1900 was the best year we have had. For eighteen months we have been behind our orders and are still behind; and in our particular line, the manufacturing of small automatic engines, the indications are that in 1901 our business will be even still better than 1900. We are buying new machinery and adding new additions to our shops.

JOHN S. NOWOTNY, Cincinnati, O.; Dynamos and Motors.—We have enjoyed in the past year an excellent business. In fact, we have done far more business than we had anticipated. We have every reason to believe that we are now just passing into an era of prosperity in this country that will extend from ocean to ocean, and we are backing up our judgment by preparing to reap the harvest for the next three years to come.

THE STODDARD TELEPHONE CONSTRUCTION COMPANY, Monroe, Mich.; Telephones.—We have found business to be exceptionally brisk during the past year and look for a large increase in the sales of our long distance telephones during the coming seaon. The demand for bridging telephones has been unprecedented, showing that the independents are looking well after their toll lines and increasing their earnings thereby.

WARD LEONARD ELECTRIC COMPANY, Bronxville, N. Y.; Rheostats and Circuit Breakers.—The year 1900 has been a very satisfactory one to us in every way. We did a much larger busines that year than ever before, and the fact that we secured the only gold medal in our line at the Paris Exposition has given a great impetus to our foreign business. Our business is growing rapidly, and we are sure that 1901 will be even better than 1900.

E. C. POWELL, Syracuse, N. Y.; Dynamos and Motors.—We have found business in this line exceedingly good during the past year. We are working a largely increased force. We have several large contracts at present, and the outlook for the new year is exceedingly bright. We seem to have more inquiries than at the same time last year, and with the amount of business in sight, hope to do a larger business in 1901 than we did this year.

ELECTRIC STORAGE BATTERY COMPANY, Philadelphia; Storage Batteries.—The development of the business of this company during the past year has been very gratifying, and especially so to those members of the company who took part in the "missionary" work that was done during the earlier years of the company's existence. The field for the profitable use of accumulators is constantly broadening, and the prospects for the coming year are most encouraging.

THE AKRON ELECTRICAL MANUFACTURING COMPANY, Akron, Ohio; Dynamcs and Motors.—Business for the past year has been the best in the history of the country. Our business has increased nearly four times over and above that of 1899, and from all indications it looks as though it will increase again at least that much, if not more, in 1901. We do not believe that the future in the electrical business has ever held out brighter prospects than at present.

THE ELECTRIC MOTOR AND EQUIPMENT COMPANY, Newark, N. J.; Photometers.—Our business for the past year has been a little more than double what it was for the year previous, and the indications are that the year 1901 will be one of the biggest years in the electrical business that has ever been known. With continuation of the present conditions of national commercial prosperity it is our impression that the electrical outlook for next year is most brilliant.

FARR TELEPHONE AND CONSTRUCTION SUPPLY COMPANY, Chicago; Telephones.—Judging from our heavy correspondence in the past month, there certainly must be a very bright prospect for the electrical trade in the beginning of the new year. Many lines and exchanges are to be rebuilt throughout, and many new exchanges are to go in. The electrical trade is certainly on the boom and we look forward to the best business the coming year that we have ever had.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio; Dynamos and Motors.—The volume of our business in 1899 exceeded by about 125 per cent the business of the previous year, and in 1900 careful estimates show that the business exceeded that of 1899 by 60 per cent. Judging from the large number of inquiries we are now receiving and the business that is resulting therefrom, we confidently expect considerably more business in 1901 than in the past year.

McINTOSH, SEYMOUR & CO., Auburn, N. Y.; Steam Engines.—The year 1900 has been better with respect to both the amount and the quality of the business than any previous year since the company was organized. The amount of business has been limited only by our capacity. Judging from the amount of work closed during the past four months, and from prospective business as indicated by inquiries, the year 1901 will fully equal, and probably surpass, the year 1900.

MICHIGAN ELECTRIC COMPANY, Detroit, Mich.; Electrical Supplies.—During the year 1900 this company has been kept busy in all of its various lines, having done, in fact, all the business we had facilities for following and handling, and we are satisfied we could have done more had our facilities been greater. As it is, however, our business shows a large gain over the business of all previous years. For 1901 we feel confident of doing even a larger business than we have done this year.

THE STILWELL-BIERCE & SMITH-VAILE COMPANY, Dayton, Ohio; Turbines, Pumps and Feed-Water Heaters.—Take it all around, this year has been the best year in the history of our company, although 1898 was also a most excellent year. Now that the political status has been so happily and satisfactorily fixed for another term of four years, we look forward to a period of great prosperity. Our inquiry is of the most hopeful character and all the indications point to an extremely busy year ahead of us.

GARTON-DANIELS COMPANY, Keokuk, Ia.; Lightning Arresters.—We have enjoyed an increase of 33 1-3 per cent over the business for 1899, which was our record-breaking year, being over double any previous year. Twenty per cent of our sales have gone abroad during 1900—this being another evidence of the superiority of American-made electrical apparatus. We look for a still greater business in 1901, and are making arrangements to begin the season with a larger stock of lightning arresters on hand than ever before.

ERICSSON TELEPHONE COMPANY, New York; Telephones.—The year 1900 went way beyond any previous year. At the close of 1899 most houses in the electrical line looked for an increase in 1900. Their expectations were fully realized in most cases, and in many were exceeded. The outlook for the opening year of the new century we believe to be most encouraging. The business conditions of the whole country are most favorable and seem to promise the assurance of a good trade, in all lines, but especially in telephones.

THE LAMBERT SCHMIDT TELEPHONE MANUFACTURING COMPANY, New York; Telephones.—We are highly satisfied with the outlook of the telephone business and certainly anticipate large results in the future. During the past year the business has developed largely, both in public exchange, interior and railroad usage of telephone apparatus. Judging from all standpoints, the outlook for the independent business could not be brighter either from the manufacturers' or from the exchanges' standpoint, and we expect to reap our share of the benefits with the rest.

HOLTZER-CABOT ELECTRIC COMPANY, Brookline, Boston, Mass.; Telephones and Specialties.—The year just closed has been a most satisfactory one. The prophesied reaction has not appeared so far, and the slight decrease in trade just before the presidential election has been followed by a steady improvement in business in all our lines of manufacture. A noticeable feature of business at the present time is the increasing demand for high-grade goods for domestic use and an increase of foreign orders. The outlook for 1901 is most encouraging, and we look forward to a steady and satisfactory business.

HENRY H. HUMPHREY, St. Louis, Mo.; Consulting Electrical Engineer.—The past year has been a very satisfactory year in my business, as I have had charge of a great deal of important engineering work. The usual amount of special investigations, tests, and reports have also been completed. The principal work on hand at present is a lighting and power plant for the DeBeers Explosive Works at Cape Town, South Africa, consisting of power plant and about 1,000 horsepower of motors, including air compressors, water-works pumping plant and refrigerating plant.

HARRISBURG FOUNDRY AND MACHINE WORKS, Harrisburg, Pa.; Steam Engines.—Last year was the most prosperous since the company's organization in 1857. Although equipped with an entirely new plant, buildings, etc., which has increased its capacity more than 100 per cent, it has received orders for engines of various styles and sizes to its full capacity and has been obliged to refuse nearly 50 per cent additional orders which have been offered. The company faces the new year with the brightest prospects and a firm belief in industrial and financial prosperity of the country.

BRYAN-MARSH COMPANY, Marlborough, Mass.; Incandescent Lamps.—The year 1900 has been the most prosperous year in our career. Our total output of incandescent lamps from Dec. 1, 1899, to Dec. 1, 1900, was 48 per cent in excess of any previous year. One reason for the heavy increase in sales is the opening up of new territory, and the large increase in foreign business through our new London office. The outlook for the future is believed to be unprecedented, and we are accordingly arranging to increase our factory output early in 1901 to from 20,000 to 22,000 lamps per day.

WARREN ELECTRIC MANUFACTURING COMPANY, Sandusky, Ohio; Inductor Alternators.—Our business has been extremely active during the entire year. Indeed, it has taxed our facilities to the utmost and at the present time we have unexecuted contracts in hand to keep our works employed to the extreme limit up to the first of next March. With regard to the prospects for 1901, it is our belief that the electrical business is to be the largest ever known. We shall be greatly surprised if every well-established electrical industry is not crowded with business during the entire year.

THE VILTER MANUFACTURING COMPANY, Milwaukee, Wis.; Steam Engines.—The past year has been one of the best since this company's existence, and the month of November was the banner month during that time. Our company has contracted for very much new business, so that the prospects for 1901, considering the number of inquiries still continuing to come in, are exceedingly favorable. We have operated our works, which are new and extensive, day and night for the past four years, and the outlook is such that we shall have to continue to do so for some time.

THE STANDARD AUTOMATIC GAS ENGINE COMPANY, Oil City, Pa.; Gas Engines.—The outlook for business seems excellent, especially in electrical lines. We have sold within the last thirty days two 250-h.p. engines; two 150-h.p engines, two 500-h.p. engines direct-connected to Westinghouse 300-kw. railway generators, and are on the point of closing a sale for four more 500-h.p. engines to drive belted alternators in parallel for street railway work; the last four all in one station. We are forced to triple our facilities to keep up with orders after having doubled our last year's output, all in large engines.

AMERICAN DISTRICT STEAM COMPANY, Lockport, N. Y.; Exhaust Steam Heating.—So far as this company is concerned, the year 1900 has been eminently satisfactory. The number of new installations and extensions constructed by us in 1900 numbers twenty-five. For lack of facilities the company was obliged to refuse some work that was offered. The outlook for the coming year is very promising indeed, and with increased facilities the company expects to accomplish more than in any previous season of its history. With the assurance of stability in the financial affairs of the country for years to come we look for a period of active business and great prosperity.

THE B. F. STURTEVANT COMPANY, Boston, Mass.; Blowers, Ventilating Fans, Engines and Dynamos.—The business of the past year was the largest in the company's history. The installation of fans for the production of mechanical draft for steam boilers has shown a great increase. The volume of domestic and foreign orders for forges has been noticeable, while the output of the rapidly growing electrical department has been far in excess of the previous year. This electrical output has been principally in the specialties of this company, namely, electric fans of all types and small generating sets. All departments have been taxed to the utmost and the outlook is favorable for the continuation of this condition.

ABENDROTH & ROOT MANUFACTURING COMPANY, New York City; Boilers.—We are closing 1900 with a very satisfactory volume of trade and of a quality particularly satisfactory. The unsteady iron and steel market which has characterized 1900 has undoubtedly retarded the buying movement somewhat, and it is generally conceded that a presidential campaign tends to have the same effect; but against both of these adverse conditions we are pleased to say that both the volume and the quality of business have been satisfactory. Indications certainly point to a strong increase in domestic buying, and we anticipate a substantial increase in the volume of business to be secured by our export department.

QUEEN & COMPANY, INC., Philadelphia; Scientific Instruments.—The apparently high prices to which raw material was forced early last year interfered somewhat with business, but as the year went on business conditions materially improved and were decidedly good during the latter part of the year. We have had a marked increase in inquiries from abroad, particularly for electrical instruments, the growing tendency to look to the United States for quality and efficiency in electrical instruments being very apparent. As the year closes we feel that business is on a more secure foundation than ever before, and there is nothing so far as we can see in the way of the development of a large and prosperous business for the year 1901.

ROE STEPHENS MANUFACTURING COMPANY, Detroit, Mich.; Valves.—The volume of business in 1900, in dollars and cents, with us is somewhat less than that of 1899, but we think the decline in prices of our goods from those prevailing in 1899 would average about 20 per cent. On this basis our output for 1900 would be larger than that of 1899, and the greatest since we have been in business. So we think with prices of material about present quotations, or possibly a little lower, there will be a large development in electrical and other lines in 1901 which will require heavy pressure machinery and fittings, and this should give us more business; so we hope 1901 will be the banner year of our existence and are preparing to meet such conditions.

THE CHICAGO RAWHIDE MANUFACTURING COMPANY, Chicago; Gears and Pinions.—Business conditions have been for us during the past year extremely favorable, both in our own city of Chicago and with our agencies in the Eastern cities. Our trade in rawhide belting, lacing and pinions is entirely with the manufacturer, so naturally we credit our own prosperity to the growth and new establishment of industries throughout the country. With the steady adoption of electrical power in plants and factories, both large and small, has come a demand for rawhide belting and pinions that has over doubled our business. We feel optimistic for a still larger increase during the coming year. Our European trade has almost kept pace with our home increase.

AMERICAN ELECTRIC FUSE COMPANY, Chicago; Fuse Wire and Links.—We are certain that the business delayed by reason of the election in 1900 is in course of preparation for 1901. This year, however, has not been in any sense a bad year; in fact, we think it has been a remarkably good one, but it is overshadowed by the overwhelming evidences of prospective business for 1901. We predict in the electrical line, which we believe to be the most progressive line in American business, the largest output in the history of the United States. The extraordinary increase in the number of inquiries and prospective orders since election warrant us in the belief that it will be necessary for electrical houses everywhere to run overtime next year to fill their orders.

GREGORY ELECTRIC COMPANY, Chicago; Second-hand Apparatus.—We have had a very satisfactory year, the increase in our business being constant and very gratifying. Through the increase in business we were compelled to enlarge our quarters and added the building 52, 54 and 56 South Clinton Street to our works in order to secure much needed additional floor space for our armature department, machine department, arc-lamp department and transformer department. We note a large demand for up-to-date apparatus, the average customer now being well posted on what constitutes good apparatus. Collections have been very satisfactory this year and we are looking forward to the coming year as one of exceptional promise. We believe the electrical industry has never been in a more satisfactory condition.

THE SHELBY ELECTRIC COMPANY, Shelby, Ohio.; Incandescent Lamps.—We have made as careful and thorough an investigation as possible through our twenty traveling representatives, with a view to determining the volume of business we can reasonably expect during the coming year. The consensus of opinion of all of our representatives is that we are to experience several years of unequalled prosperity. The questions that have been decided by the recent election have been decided in a way that has encouraged manufacturing industries in all lines, and this company is and has been enjoying the greatest volume of business it has ever experienced. We have been constantly increasing our capacity and believe that if everyone is meeting with the same success that we are there will be no cause for complaint from any source.

THE C & C ELECTRIC COMPANY, New York; Dynamos and Motors.—We are pleased to be able to advise you that the year 1900 has proved in every respect the most successful year this company has ever experienced. Our sales were far larger than they ever were before, and we start the new year with a very large balance of orders; in fact, enough to keep our factory running at its fullest capacity for several months. It is our belief, and we think there is every indication to prove its reasonableness, that 1901 will be a decidedly better business year than 1900 has been. The increase in capacity which will be made by large numbers of manufacturing establishments will mean an increase in demand for electrical machinery in 1901, and we expect to get quite our share of the new orders. Orders for export have been constantly increasing, and we look for a very much larger increase during the next year in this branch of our business.

BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio; Electric Light and Power Equipments.—We have had a most satisfactory trade during 1900, the last six months of which shows a greater volume of business done than the entire year of 1899. We have found it necessary to twice enlarge upon our facilities during the year, which will make the capacity January 1st, 1901, fully double that which it was January 1st of 1900. One gratifying feature of our business this year has been the large increase in export trade. Orders have come to us from Great Britain, Continental Europe, Russia, South America and Mexico with every indication that there will be a gradual and very satisfactory increase in the future. Another feature of our business is that during 1899 our largest unit was an 800-kw., while at the present moment we are prepared to build generators of 2000 kilowatts and larger if necessary. We are to-day crowded with orders for large units.

AMERICAN STEEL AND WIRE COMPANY, Chicago, Ill.; Wires and Cables.—The company's business in wires and cables for electrical purposes during the year 1900 has been very satisfactory. The production and sales show a large increase over any previous year in the history of the Washburn & Moen plants, where these goods are manufactured. The increases have been quite general in all departments of electrical products, but the greatest gains have been noted in the sale of "Crown" bonds and feeder cables of large capacity for light and power circuits. In these lines the producing capacity of the company has been taxed to its utmost. The distribution of orders has been quite general over all sections of the country and the increase in export orders has been very gratifying. The company is decidedly optimistic regarding the outlook for 1901. Every indication points to a still further increase in the demand for electrical products, and plans are maturing for very largely increasing the capacity of the mills engaged in turning out electrical specialties.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y.—The business done during the year 1900 shows a large increase over that done in 1899, notwithstanding the fact that the latter year's business was the best in the history of this company. The number of new projects requiring large quantities of electrical apparatus and supplies have been numerous during the year. The prices of the raw materials chiefly used in the electrical work remained at the high record made during the year 1899, until November last. Since then actual advances have been demanded on these prices which, if continued, must ultimately lead to increased prices for finished electrical products. During the year noted improvements have been made in the equipment of central station lighting apparatus, the older and more inefficient types of generators and devices having been discarded and replaced by larger units of higher efficiency and of a more substantial character. In electrical railway work there has been a decided tendency toward the use of four motors per car instead of two, thus giving greater power, higher speed and generally more satisfactory service. The increasing demand for railway equipments for suburban and interurban work shows clearly the tendency on the part of all railway companies to extend their lines. Great advances have been made during the year in the equipment of large manufacturing plants with electric motors; the practice of equipping each tool with an individual motor is notable in machine shops of recent construction. So rapid has been the strides in the successful transmission of power by electricity over considerable distances, that the limiting factor is no longer the length of the transmission line, but is now merely a question of the market price at which the power can be sold. Power at a loss of only 8 per cent on the line is to-day being transmitted 80 miles in California. By electrical equipment, many water-powers, heretofore considered so inaccessible as to be of no commercial value, are now among the most desired of all properties. The electrical transmission of power from coal mines (using slack for fuel) is beginning to attract the attention of capitalists, and there are several plants of this character in different sections of the country which have proved to be great commercial successes.

LEGAL NOTE.

DIEHL FAN PATENTS SUSTAINED.—A perpetual injunction has been issued by the United States Circuit Court for the Eastern District of Pennsylvania, restraining the Marietta Manufacturing Company and H. Burd Cassel, Receiver, from the manufacture and sale of electric ceiling fans infringing the Diehl patents Nos. 465,360 and 465,361, dated December 15, 1891; No. 537,679, dated April 15, 1895, and No. 585,250, dated June 29, 1897.

OBITUARY.

WASHINGTON H. LAWRENCE, president of the National Carbon Company, died on November 23, at his home in Dover Bay, near Cleveland, from the effects of a broken arm. The bone failed to knit, and it was decided to amputate the arm, which was done, but with fatal result. Mr. Lawrence had been identified with electrical industries since the organization of the old Brush Electric Company, for which he furnished much of the capital. Later on he severed his connection with the Brush Company and devoted his attention to other branches, from which he selected the manufacture of carbons as his particular line of work. He combined with Myron T. Herrick, James Parmalee and Webb C. Hayes in forming the National Carbon Company, and many of the developments and improvements in the methods of manufacture are directly due to his ingenuity and foresight.

PERSONALS.

MR. C. W. WOODWARD has been appointed purchasing agent for the Electric Storage Battery Company to succeed Mr. John B. Falkner, Jr., deceased.

MR. J. M. HOLLISTER, who represented the Western Electric Company at Paris, read an extremely interesting paper on the "Electrical Features of the Paris Exposition" before the Chicago Electrical Association on December 21.

MR. FRANK C. MASON, general superintendent of the Police and Fire Alarm Telegraph System of Brooklyn, read an interesting paper on "The Fire Departments of our Cities" at a convention in Charleston, S. C., on December 13.

MR. W. S. ANDREWS read an interesting paper before the Schenectady General Engineering Society recently, on "Roentgen Rays," which has been reprinted in the shape of a little brochure, the illustrations of which include portraits of Roentgen and Faraday.

MR. MORRIS W. MEAD, superintendent of the Electrical Department of the city of Pittsburg, had the misfortune to have one of his legs broken one day recently by a fall from a ladder, due to the breaking of one of the rungs. Mr. Mead will be confined to his home for several weeks.

MR. R. S. STEARNS, recently connected with the New Orleans office of the Westinghouse Electric & Manufacturing Company, and formerly with the General Electric and Fort Wayne companies, relinquished his position with the Westinghouse Company on January 1 to engage in general contracting business.

MR. V. H. YARNALL has been appointed manager for the eastern district by Mr. John T. McRoy, maker of the well-known McRoy conduit. Mr. Yarnall's territory will also include Canada. Mr. Yarnall is widely and most favorably known in engineering circles, having been an active worker since 1882.

MR. H. C. WYBRO, manager of the Wybro-Hendy Company, of San Francisco, was recently in New York on a business trip for his company. While in the East, Mr. Wybro secured the contract for the three-phase transmission plant of the McCloud River Electric Power Company for the Bullock Electric Company, which he represents in California.

MR. FREMONT WILSON, who is well known in New York electrical engineering circles, read a paper on "Electrical Wiring" before a recent meeting of the Brooklyn Chapter of the American Institute of Architects. The paper was an able one and interest in it was enhanced by the lantern slides which illustrated the various points brought out by Mr. Wilson.

MR. ADOLPHE A. CHAILLET, hitherto technical manager for the Shelby Electric Company, has resigned that position to engage in consulting electrical and mechanical engineering. Mr. Chaillet has established his headquarters in the Ellicott Square Building, Buffalo; he will continue to be the technical adviser of the Shelby Company and will represent its lamp in his section of New York State.

MR. EDWIN R. WEEKS, ex-president of the National Electric Light Association, and one of the most active workers in that association, has established an office in the new Nelson Building, Kansas City, and will engage in electrical engineering. Mr. Weeks has been for many years at the head of the electric-lighting interests of Kansas City and is widely known as a central-station engineer of high ability.

MR. JAMES PARMELEE has been elected president of the National Carbon Company, Cleveland, Ohio, to succeed the late Mr. W. H. Lawrence. Mr. Parmelee has been the vice-president of the company since its organization, and is also the treasurer of the Wheeling & Lake Erie Railroad Company. Mr. Parmelee's vacated position of vice-president has been filled by the appointment of Col. Myron T. Herrick.

MR. B. A. BEHREND has been engaged by the Bullock Electric Manufacturing Company as designing electrical engineer, for which position he is admirably qualified. Mr. Behrend was formerly chief designer of the Oerlikon Works, Switzerland, and has been for several years an important contributor to electrical literature. He was tendered the chair of electrical engineering in the Technical Institute of Stuttgart, Germany, last spring, which is one of the finest professorial positions in Germany, but declined the offer.

MR. LUDWIG GUTMANN, who has for several years been the designing engineer for the Royal Electrical Company, of Peoria, Ill., and whose high ability in this direction wrought notable improvements in the machinery and apparatus of that company, has resigned his position in order to engage in general engineering work and also to put some of his inventions in commercial shape. Fundamental patents covering important types of apparatus were granted to Mr. Gutmann a number of years ago, among which apparatus is the induction wattmeter recently put on the market in the West.

MR. ALLEN D. SKINNER, the popular traveling representative of the Skinner Engine Company, Erie, Pa., was married on Christmas eve to Miss Florence Robinson, at the Park Presbyterian Church, Erie. The bride and groom have received almost innumerable tokens of the esteem in which both of them are held by wide circles of friends. It is seldom that a man who is given the privilege of selecting his own Christmas present makes such a judicious choice as has Mr. Skinner, and still more seldom that such high ambition is so promptly gratified. The American Electrician tenders its best wishes and the compliments of the season.

◆

TRADE PUBLICATIONS.

CALENDAR. The Standard Tool Company, Cleveland, Ohio.—A hanging calendar of the usual monthly-leaf form, each leaf containing a pointed statement regarding Standard drills, taps, etc.

BELT-DRIVEN SINGLE-PHASE ALTERNATORS. Westinghouse Electric & Manufacturing Company.—Circular No. 1036, superseding No. 1008, and describing the well-known Westinghouse alternators.

ROUND-END RAILWAY CAR-SEAT PANELS. J. G. Brill Company, Philadelphia, Pa.—Catalogue No. 67, describing the round-corner seat end panels employed by the Brill Company in the construction of open railway cars.

FLEXIBLE METALLIC TUBING. The United Flexible Metallic Company, Ltd., Philadelphia, Pa.—A catalogue of flexible metallic tubing, which is manufactured for all purposes, including the conduction of steam, gas and water.

NEW ERA GAS AND GASOLINE ENGINES. The New Era Iron Works Company, Dayton, Ohio.—A well-executed catalogue of standard size containing illustrations and a description of the New Era engines in considerable detail.

RAILWAY MOTOR CONTROLLERS. General Electric Company.—This is Bulletin No. 4288, superseding Bulletin No. 4215, and containing descriptions and illustrations of the full line of G. E. series-parallel and rheostatic controllers.

THE STURTEVANT ENGINES. B. F. Sturtevant Company, Boston, Mass.—Catalogue No. 103, in which are illustrated and described the well-known Sturtevant vertical and horizontal steam engines for electric light and other service.

CALENDAR. New England Electrical Works, Lisbon, N. H.—A very practical calendar for 1901, consisting of a heavy cardboard back with the New England company's advertisement at the head and the usual monthly calendar leaves at the bottom.

HOLOPHANE GLASS. Holophane Glass Company, New York.—A well-executed brochure containing illustrations of the complete line of Holophane globes for electric-light service and also containing an inserted price-list applying to the catalogue.

CALENDAR. The Bliss-Chester Company, Providence, R. I.—A hanging calendar for 1901 of the usual form but containing a novel illustrative feature, which consists of a photograph of a vivid flash of lightning taken at Hallett's Point near Hell Gate during a severe thunder storm.

CALENDAR. The Emerson Electric Manufacturing Company, St. Louis, Mo.—A convenient desk calendar in pad form mounted in a sheet-metal frame and containing a leaf for each day of the new year. Each leaf bears at the top a pertinent motto relating to Emerson apparatus.

CHARTER GAS AND GASOLINE ENGINES. Charter Gas Engine Company, Sterling, Ill.—A catalogue of the well-known Charter gas and gasoline engines, which contains a thorough description of the engine illustrated by sectional and detail engravings, complete to a degree seldom found in gas-engine catalogues.

MOTOR-DRIVEN DUPLEX AIR COMPRESSORS. The Westinghouse Air Brake Company.—A handsomely-illustrated catalogue of self-contained air compressors and motors for use on electric-railway cars. The motor, as just intimated, is built on the same base with the compressor, so that each unit is complete in itself.

TYPE "H" TRANSFORMERS IN USE. General Electric Company.—Pamphlet No. 9085, containing fac-simile reproductions of letters from central-station men relating to their experiences with G. E. Type "H" oil transformers. The letters are all strong testimonials to the satisfactory results obtained from these transformers.

TELEPHONE APPARATUS. Central Telephone & Electric Company, St. Louis, Mo.—This is the seventh catalogue of the Central Company and contains illustrations and prices of the standard telephone desk and wall sets made by the company, together with an illustration and description of its full metallic-circuit central switchboard.

BRILL CONVERTIBLE CAR. J. G. Brill Company, Philadelphia, Pa.—A well-illustrated catalogue of the Brill convertible car, which is adapted to be changed from the open to the closed form and vice versa by means of sliding panels and windows. These are pushed up into recesses in the roof of the car in changing from closed to open construction.

MODERN STEAM GENERATORS. (Supplement.) Wickes Brothers, Saginaw, Mich.—A supplementary catalogue of standard size containing illustrations and a complete description of the Wickes vertical water-tube safety steam boiler. The book also contains a record of the results of an evaporative test made with a Wickes boiler at the Detroit Water Works.

SALARIED POSITIONS FOR LEARNERS. The International Correspondence Schools, Scranton, Pa.—A pamphlet containing photographs of a number of students who have been enabled to better their positions by reason of a course of studies with this school, and an outline of an advisory plan for persons wishing to avail themselves of the Correspondence Schools.

MASON TERRA-COTTA CONDUITS. The Potomac Terra Cotta Company, Washington, D. C.—A folder containing illustrations and a description of the Mason vitrified salt glazed terra-cotta underground conduit, together with a statement of the points of superiority claimed for this product and several strong testimonial letters from electric light and other companies which have used the conduit.

THE STEAM LOOP AND HOLLY GRAVITY RETURN SYSTEM. Westinghouse, Church, Kerr & Company, New York.—This is a superbly-executed book of standard catalogue size containing illustrations of representative plants in which the steam loop and Holly gravity return systems have been installed, together with an explanation of the principle of this system and a logical argument for its use.

WIRES AND CABLES. American Steel & Wire Company, Chicago.—This is a preliminary pocket-size catalogue of wires and cables for electric light, street railway, telephone and telegraph service, which will be followed later by a more complete and elaborate edition. The present production, however, will be found extremely convenient by those interested in the purchase of wire for any electrical service.

LEEDS PORTABLE TESTING SETS. Jas. G. Biddle, Philadelphia, Pa.—This is pamphlet No. 340, in which are described the various styles of testing sets marketed by Mr. Biddle, together with complete instructions for making Wheatstone bridge measurements, expositions of several methods of testing circuits and batteries, and checking voltmeters and ammeters. The information contained in the pamphlet is unusually practical and valuable.

CALENDAR. Kurz & Root, Appleton, Wis.—A calendar of the hanging type comprising a cardboard back with a calendar leaf for each month of the year. The upper part of

A COMMUTATOR NECESSITY.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.
50c. per Stick. $5.00 per Dozen.

For Sale by all Supply Houses.
Upon receipt of this coupon we will send FREE, sample stick.

Name...
Address..
A. E.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO.

the cardboard base bears an unusually interesting illustration giving a view of the interior of the old Appleton central station which was the first one in America to supply incandescent light. This station was started up in October, 1882, under the management of Mr. Kurz, who is now the senior partner of the firm issuing the calendar.

THAT DEVIL DOUBT. The Emerson Electric Manufacturing Company, St. Louis, Mo.—A pamphlet handsomely printed on plate paper containing strong testimonials to the efficiency of Emerson alternating-current motors. While most of the letters are written by American users a considerable number come from distant parts of the world; notably, Hong Kong, China; Buenos Ayres, Argentine Republic, and Sydney, Australia. The raison d'etre of the title of the pamphlet is explained in the opening paragraph, which points out that the object of the catalogue is to remove from the minds of central-station managers who are not already converted any doubt as to the practicability of single-phase alternating-current fan motors.

BUSINESS NEWS.

WESTERN ELECTRIC COMPANY announces that it is prepared to supply arc-light carbons in any quantities for both direct-current and alternating-current lamps.

M. R. MUCKLE, JR. & CO., Philadelphia representatives of the Westinghouse interests, have removed their offices to the Stephen Girard Building, 21 South Twelfth Street, Philadelphia.

THE INDUSTRIAL WATER COMPANY, New York, announces that it has only the one office address, viz.: 15 Wall Street, New York, and that another company with a similar name has no connection with it.

D. M. STEWARD MANUFACTURING COMPANY, Chattanooga, Tenn., manufacturer of lava insulators, reports that it is filling orders from all parts of the world; especially large quantities are being sent to Germany.

THE SPRAGUE ELECTRIC COMPANY, New York, has just closed a contract for a large number of 20-h.p. slow-speed motors of the direct-connected type for operating the button machinery in the new plant of the Delaware Button Company at Wilmington.

M'KENNA BROS. BRASS COMPANY, Pittsburg, Pa., announces that since the establishment of its switchboard department it has received a great many orders for switchboards, and is receiving every day large numbers of requests for quotations on electrical work.

THE ELWELL-PARKER ELECTRIC COMPANY, Cleveland, Ohio, suffered the destruction of its plant by fire on December 17. The plant of the Brown Hoisting & Conveying Company was also destroyed by the same fire, the total loss being nearly a million dollars.

THE UNITED STATES CARBON COMPANY, Cleveland, Ohio, announces that contrary to all precedent, it will hereafter quote publicly the net prices of its carbons. This departure will naturally attract considerable attention, as it has been heretofore customary only to make quotations privately to prospective buyers.

ELMER P. MORRIS & CO., New York, have just closed a contract for 32,000 ft. of conduit duct for the Potomac Terra Cotta Company, Washington, D. C., to be used in connection with the Rapid Transit underground railway in New York City. This order will require eight freight cars for its transportation.

WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has removed its San Francisco office from 120 Sutter Street to 593 Mission Street, where much better facilities and more advantageous show rooms will be enjoyed. Mr. Clark, the company's representative in California, will continue in charge of the office.

THE AMERICAN BATTERY COMPOUND COMPANY, Chicago, Ill., has changed its name to the American Compound Company and removed its laboratories to 345-347 South Clinton Street. The sales department of the company has been placed entirely in the hands of the American Electric Fuse Company, who will therefore handle the "A B C" compound hereafter.

PARTRICK, CARTER & WILKINS, Philadelphia, have removed their offices to 1231-1239 Callowhill Street, and their factory to 407-409 North 13th Street. The buildings to which the firm has removed its offices and factory are new ones, and the superior accommodations obtained will enable them to more satisfactorily take care of their rapidly increasing business.

THE WARREN COMPANY, Chicago, Ill., manufacturer of the Warren pulley cover, has on file a large number of strong testimonial letters concerning this pulley covering. Fac-similes of several of these letters which the company is distributing amply confirm this claim, as the tone of the letters is universally commendatory and indicative of thorough satisfaction on the part of the users.

ANCHOR ELECTRIC COMPANY, of Boston, Mass., is urging the importance of installing only the best grade of fuse-blocks in connection with electric wiring. The company manufactures a line of fuse-blocks made from the finest grade of vitrified porcelain that can be obtained, and the goods are made in strict accordance with the requirements of the Code of Underwriters' National Association.

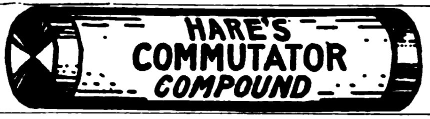
THE NEW ERA IRON WORKS COMPANY, Dayton, Ohio, manufacturer of gas and gasoline engines, reports that although the capacity of its plant has been doubled within the last few months, it is still very much behind its orders. The New Era line of engines ranges from 5 horse-power to 125 horse-power, and these engines have made a most creditable record, as the condition of the company's order books testifies.

JAMES McCREA & COMPANY, Chicago, manufacturers of steam specialties, have recently placed an agency for the Climax steam joint clamp with Geo. I. Roberts & Bros., 471 and 473 Fourth Avenue, New York, who will carry a complete stock and are in a position to fill all orders promptly. They have also placed an agency for the Pacific Coast with Pierce, Birs & Co., 31 Main Street, San Francisco, who will also carry a stock of the clamps.

JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., manufacturer of graphite preparations, calls attention in a recent is-

Telephone Service
puts the hall-mark of real comfort on a well-appointed private residence.
Telephone Service
puts the whole organization of a great city at your fingers' ends, day and night, in all weathers.
Rates in Manhattan from
$5 a Month.
One year contracts. Monthly payments.
NEW YORK TELEPHONE CO.
15 Dey Street. 111 West 38th St.

A
NEW BOOK
On the Design and Construction of
OIL ENGINES.
Contents of Chapter V.—Oil Engines Driving Dynamos—Isolated Plants—Advantages of Oil Engines—Installation of Plant—Foundations—Location of Engine and Dynamo—Belts—Balance Wheels on Armature Shafts—Power Required for Incandescent and Arc Lighting—Losses of Power by Belts, etc.—Regulation of Engine for Lighting—Direct-connected Plants—Advantages—How to Remedy Variations in Lights, etc., etc.
210 Pages. 79 Illustrations. Cloth, $2.00.
ACCUMULATORS.
How to Make and Use Them. Fully Illustrated. By PERCIVAL MARSHALL. 12mo, Cloth, 50c
INDUCTION COILS
AND
COIL MAKING.
Their Construction, Operation and Applications, with Chapters on Batteries, Tesla Coils, X-Rays, etc., etc. By H. S. NORRIE. Fully illustrated. 193 pages. Cloth, 50c.
SPON & CHAMBERLAIN,
12 CORTLANDT ST., NEW YORK, U.S.A.
Copies mailed postpaid to any address on receipt of price.



BIG STICK, 35 CENTS.
Sample Free.
SOUTHWORTH & HARE,
Indianapolis, Ind.

A WONDERFUL ALL METAL RECEIVER.
NEEDS NO ADJUSTING. STRONGEST IN THE WORLD.
ERICSSON
SWEDISH
BI-POLAR
RECEIVER
4½ lbs
4½ lbs
IT IS THE BEST. WHY NOT HAVE IT?
ERICSSON TELEPHONE CO. 296 Broadway N.Y.

PLATINUM
In Sheet or Wire, any Degree of Hardness. FOR ALL PURPOSES.
BAKER & CO.,
NEWARK, N. J.
New York Office, 120 Liberty Street.

sue of its little advertising periodical to the fact that Dixon's flake graphite, which has come into universal use for engine lubrication, can be used in an ordinary squirt can, just as oil is applied. It is of course essential that the can be absolutely dry; one which has previously contained oil will cause the graphite to clog.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, has almost completed a large addition to its machine shop and a new building for the accommodation of the brass foundry, boxing and brass-polishing departments. These additions were rendered necessary by the phenomenal growth of the Bullock company's business, and when they are completed it will be in position to more promptly take care of its rapidly multiplying orders.

THE AMERICAN SCHOOL OF CORRESPONDENCE, Boston, Mass., is sending out a special money card to be used by engineers and others desiring to examine the instruction papers and text books of the school. The card contains a pocket in which a silver 25-cent piece may be inserted and securely sealed, and a place for the sender's name and address and the name of the text book wanted. The card may be placed in an envelope and addressed to the school without the trouble of writing a letter or obtaining a postal order.

SPON & CHAMBERLAIN, New York, report that the new book on oil engines by Mr. A. H. Goldingham, although it has been out only a few weeks, has met with such favor that the first lot of books received from the printers has been entirely exhausted, over 500 copies being sold within the past four weeks. The book is said to be of special interest to draughtsmen and others interested in design, construction, installation and operation of oil engines. A review of it will be published in the proper department of this paper at an early date.

MR. HENRY B. CUTTER on December 15 retired from The Cutter Company, Philadelphia, his interest in the business established by him having been purchased by others who are represented by A. Edward Newton and Wm. M. Scott. Mr. Newton, who assumed the financial management of the company five years ago, has been elected president; Mr. Scott, who has been the chief engineer and patentee of the apparatus manufactured by the company, has been elected vice-president and general manager. It is understood that Mr. Cutter will retire from active business.

THE REPLOGLE GOVERNOR WORKS, Akron, Ohio, states that engineers and users of water-wheels are learning not to expect impossibilities. All that a water-wheel governor can do is to open and close the gates as the falling or rising speed may demand. This is precisely what a steam-engine governor does, but no one would think of asking the governor to control speeds for heavy changes of load on a steam engine that had no fly-wheel, and had a supply pipe only half the normal size for the full load. There are hundreds of water-power plants that offer substantially these conditions, and yet demand speed regulation for heavy changes of load.

NORTHERN ELECTRICAL MANUFACTURING COMPANY, Madison, Wis., has been awarded the contract for a complete new lighting plant by the city of Detroit, Mich. The machinery is to be of Northern and Stanley make. The city only considered two bids besides that of the Northern company, and a peculiar feature of these bids was their closeness, one of the other bids being only $9 higher than that of the Northern company. The fact that a contract of this magnitude and importance was entrusted to the Northern company, a comparatively young organization, is striking testimony to the reputation which it has made during its active existence.

THE BALL ENGINE COMPANY, Erie, Pa., recently received a most flattering letter from Mr. F. E. Drake, Director of Machinery and Electricity at the recent Paris Exposition, relating to the performance of the Ball Company's 300-h.p. engine at Vincennes. Mr. Drake states: "Our plant was the first of the entire Exposition installations to be put into active service, and since the starting of your engine we have never had a moment's shut-down or the least difficulty which could in any way be traceable to the engine. It has operated noiselessly and continuously and has made many friends among the foreigners who have visited the plant." These engines received a gold medal from the International Jury of Award at the Exposition.

THE CROUSE-HINDS ELECTRIC COMPANY, Syracuse, N. Y., received last month a most gratifying letter from the Manhattan Light, Heat & Power Company, of St. Paul, Minn., with reference to some switches which that company had previously purchased. The letter states that the prices which were quoted on the switches were somewhat higher than those quoted by other makers, and the purchasers had on that account naturally expected that the switches would be above the average in quality. When the switches came to hand, however, they greatly exceeded the anticipations of the purchasers, who were thereby moved to express their appreciation to the Crouse-Hinds Company and compliment them on the excellence of the apparatus furnished.

AMERICAN DISTRICT STEAM COMPANY, Lockport, N. Y., announces that the idea of central station heating seems to be taking a firm hold of the public mind in all wide-awake cities and villages. At the commencement of this season the company was employed installing over a mile of underground steam mains for the Seattle (Wash.) Electric Company, the largest pipe being 18 ins. in diameter. The work was completed in early autumn, and the Seattle company already has a large heating patronage, all the service being with exhaust steam. Something over two miles of mains have also been completed for the Atlanta (Ga.) Railway & Power Company. This is now in operation, and the company is serving exhaust steam for heating purposes to between thirty and forty customers, some of them being very large users.

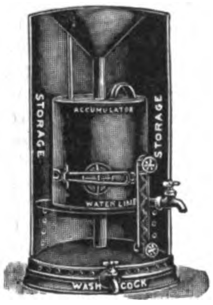
THE STANDARD AUTOMATIC GAS ENGINE CO., Oil City, Pa., recently completed two engines of 600 horse-power each which are to be direct connected to Westinghouse 300-kw. generators, and has under way for the same customer two 150-h.p. engines for electric lighting. The company expects to close a contract for four 600-h.p. engines, all belted to alternators running in parallel on mixed load of arc and incandescent lights and rotary converters supplying current for a street railway. A novel and effective idea which will be used in installing this last plant will be that all the alternators will be placed in mechanical alignment and all or any two of them may be connected together by magnetic clutches, thereby being made to run absolutely in unison, distributing the load on all engines that may be running at the time, and entirely obviating any tendency toward hunting or racing.

THE STOREY GENERAL ELECTRIC COMPANY, successor to the Storey Motor & Tool Company, Harrison, N. J., manufacturer of dynamos and motors, has completed the removal of its offices and factory from Trenton, N. J., to a larger and newly equipped factory at Harrison, N. J. The new company, which is capitalized at $3,500,000, is the outgrowth of the steadily increasing demand for the well-known Storey motors, and with the larger facilities in shop room, machinery, etc., which are at its disposal will soon be in a position to handle a much greater volume of work in the same lines as those previously followed, and also to take up a number of additional lines which it was impossible to handle before on account of the lack of proper facilities. Mr. I. E. Storey, the proprietor of the old Storey Motor & Tool Company, is president of the new concern and has associated with him men who have both the ability and capital to push the new company forward to a prominent position in the electrical manufacturing field.

SOLID TRAINS TO NORTHERN MICHIGAN.

The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

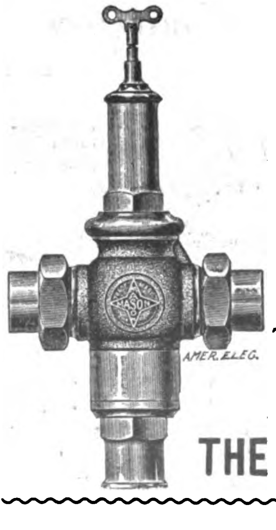
All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.



The TRACY OIL FILTER

Perfect Filtration fully guaranteed. Will positively save 75 per cent. of your oil bills.
Send for circular.

Phœnix Automatic Filter Co.,
Racine, Wis., U. S. A.



THE MASON Reducing Valves

ARE THE WORLD'S STANDARD VALVES

For automatically reducing and absolutely maintaining an even steam or air pressure.

They are adapted for every need and guaranteed to work perfectly in every instance.

WRITE FOR FULL INFORMATION AND SPLENDID REFERENCES.

THE MASON REGULATOR CO., Boston, MASS., U. S. A.

American Electrician.

Vol. XIII. New York, February, 1901. No. 2.

INDUCTION MOTORS IN A TOBACCO FACTORY.

THE POWER PLANT OF THE WETMORE TOBACCO FACTORY.

BY F. E BAUSCH.

The recent installation of an electric light and power plant in one of the largest independent tobacco factories in the United States presents an interesting application of the polyphase alternating-current system of power distribution, and the facility of handling a great variety of independent machines scattered on the various floors of an immense building, demonstrates strikingly the merits and success of this class of electrical operation. The plant of the M. C. Wetmore Tobacco Company, of St. Louis, Mo., with a capacity of 100,000 lbs. of tobacco daily and a pay-roll numbering about 1200 people, is the one under consideration.

South of the middle division of the factory is located the boiler-room, 80 ft. long, 50 ft. wide and 18 ft. high. There are six 150-h.p. horizontal boilers, built by the John O'Brien Boiler Works Company, of St. Louis, Mo., set in pairs. The boilers are supplied with Hawley Down Draft furnaces, consisting of one front and one rear manifold, with connecting grates. The smoke-stack stands alone and is anchored to a cast-iron base plate. It is 60 ins. in diameter and 100 feet high, inclined, the lower half being made of 3/16-in. steel and the upper half of No. 10 steel, with rings 5 ft. wide. The stack was also built by the John O'Brien Boiler Works Company. The steam auxiliaries are of the usual types.

The engine is a heavy-duty Corliss 18x36-in., built by the St. Louis Iron and Machine Works, St. Louis. It is located in the basement near the north wall of the middle division of the building. Its rating is 250 horse-power at 100 r.p.m., and 100 lbs. steam pressure. The engine has a 10-ton fly-wheel, 14 ft. in diameter. The valve gear is the standard hook releasing type, and the regulation of the engine is held within 2 per cent under all changes to load within full capacity.

The generator is a three-phase 230—133-volt General Electric alternator, with double voltage for lights and power. It is rated at 200 kilowatts, and is direct connected to the engine. The armature is Y-connected, and four-wire distribution is used throughout the building, the pressure between the "neutral" and any one of the outside wires being, of course, $\frac{1}{\sqrt{3}}$ of the pressure between the outside wires.

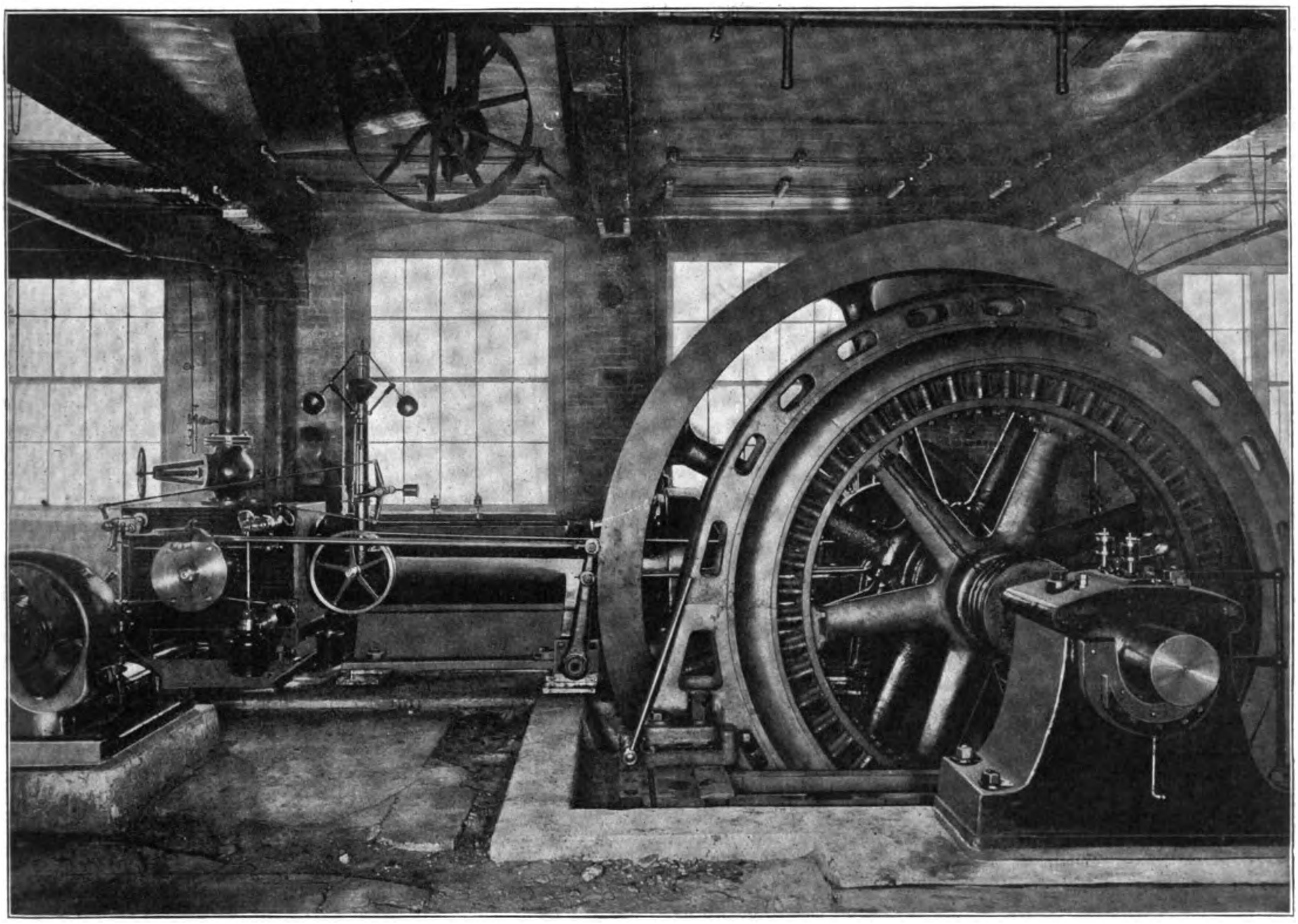


FIG. 1.—ENGINE AND THREE-PHASE ALTERNATOR IN THE POWER HOUSE.

The frequency is 40 cycles. A small direct-current unit is driven by a 25-h.p. Chase engine. This in day-time serves as the exciter for the alternator, and at night is used for incandescent lighting.

There are 23 General Electric induction motors, ranging from 1 to 30 horse-power and operated at 220 volts. The rotors of these motors are of the squirrel-cage type. The apparatus used to prevent excessive current rush at starting is a compensator connected in the motor primary or exciting current, as shown by Fig. 10. This arrangement cuts down the starting e.m.f. as well as the current, but this is not objectionable, as the maximum starting torque is not required. For full-load torque at starting the motors here used require approximately four times the full-load running current. If, therefore, the starting current must be kept at or below full-load current the motor cannot be expected to exert more than a quarter of full-load torque at starting.

For motors of 15 horse-power and under the compensator starters have three taps giving voltages of 40 per cent, 60 per cent and 80 per cent of the full circuit voltage. Compensators for motors above 15 horse-power have four taps, giving voltages of 40 per cent, 58 per cent, 70 per cent and 85 per cent of the circuit e.m.f. Motors with compensators are proportioned so that the primary and secondary have low self-induction. They contain a minimum amount of copper and a considerable amount of iron. These motors are especially adapted for factory work, the conditions involving light starting loads and practically constant full loads when up to speed.

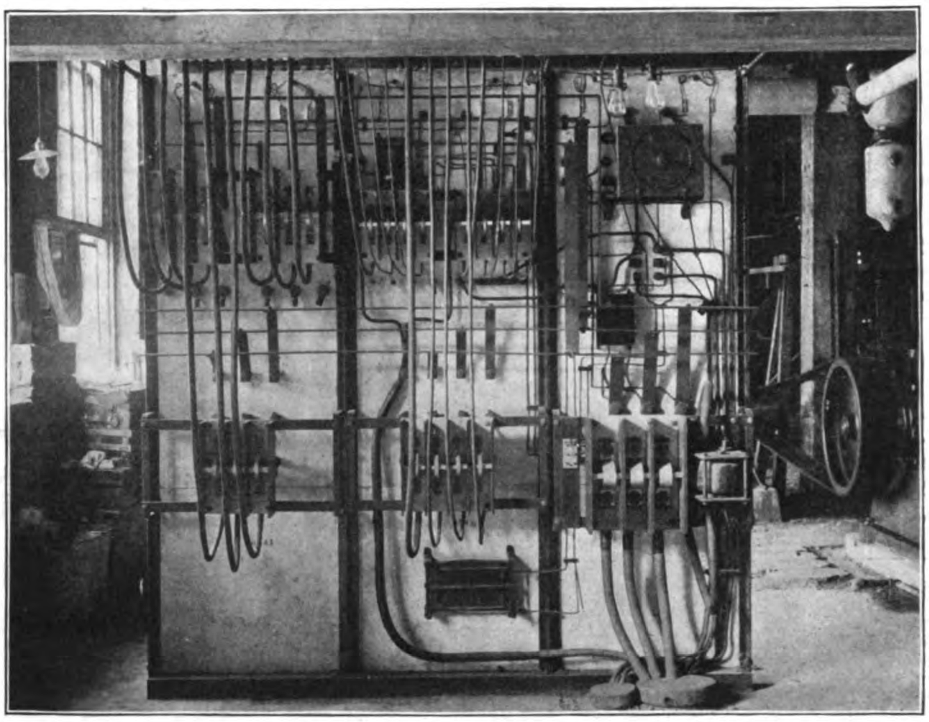


FIG. 3.—THE BACK OF THE SWITCHBOARD.

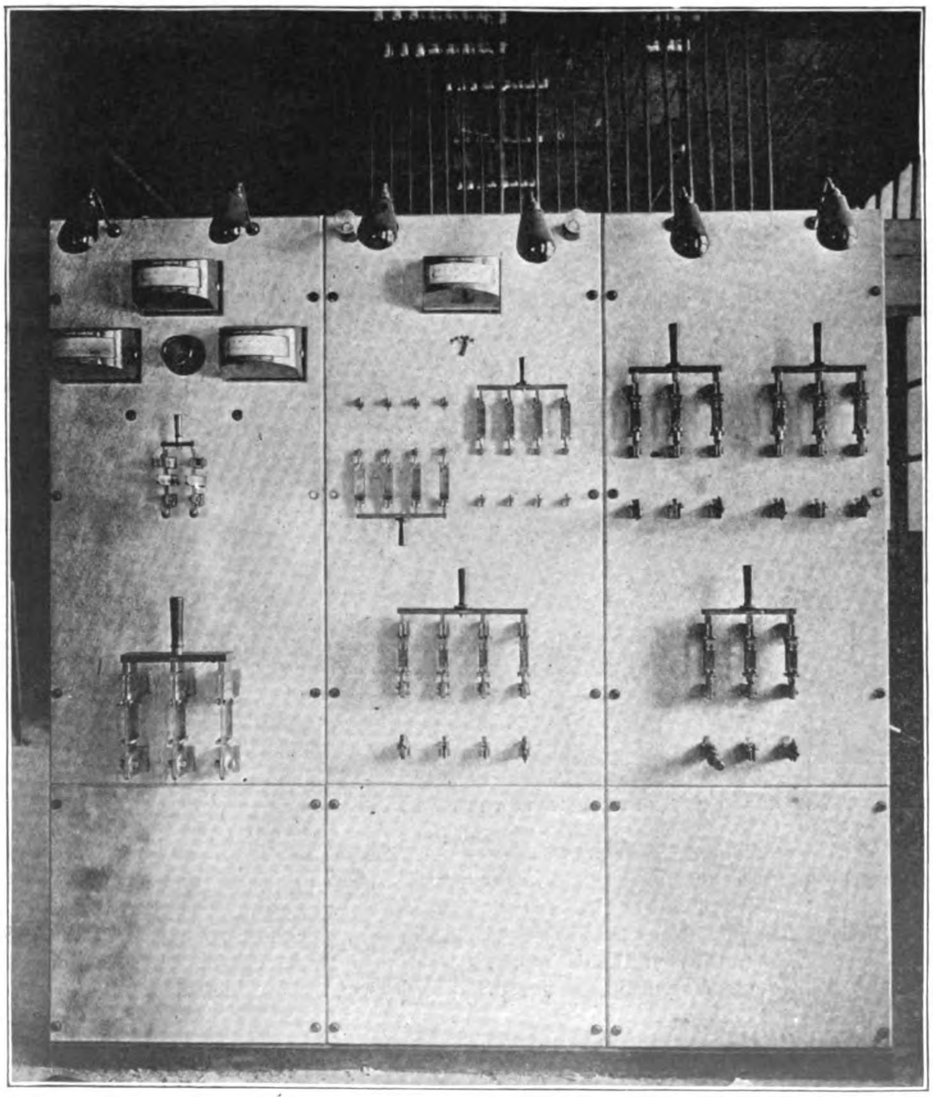
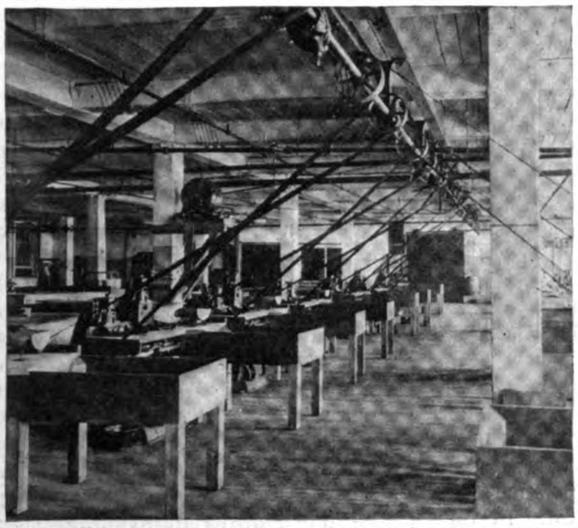
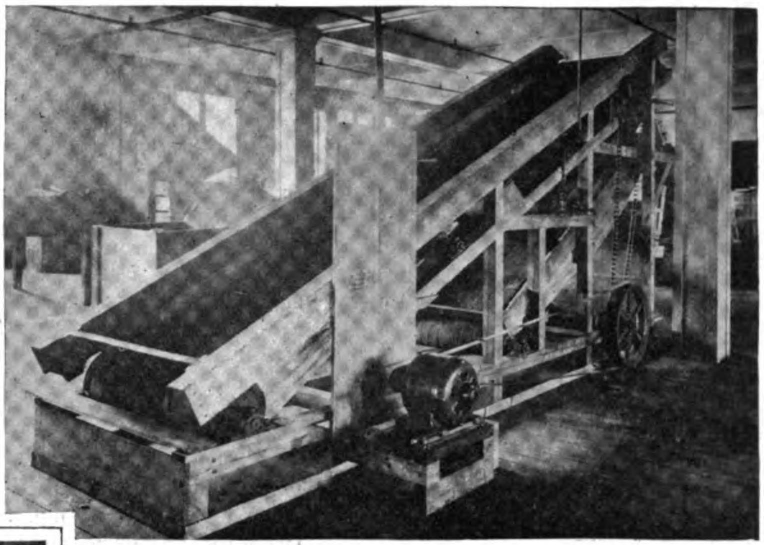


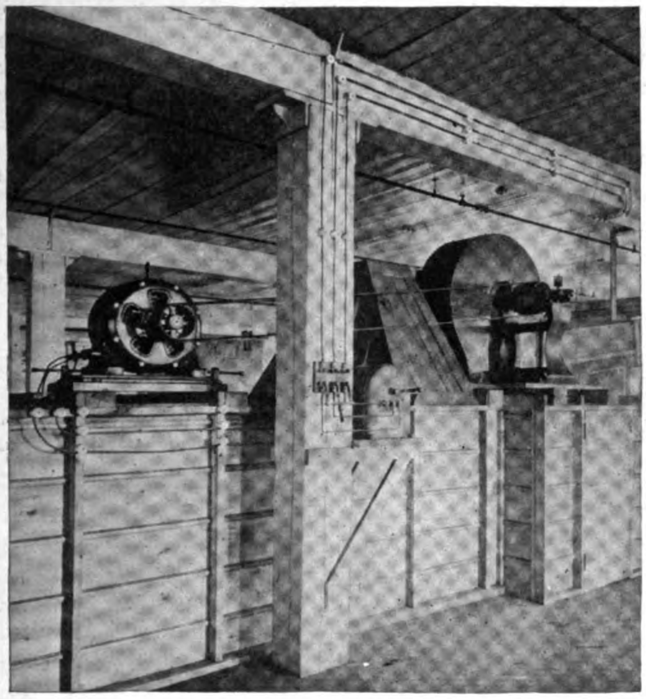
FIG. 2.—THE FRONT OF THE SWITCHBOARD.

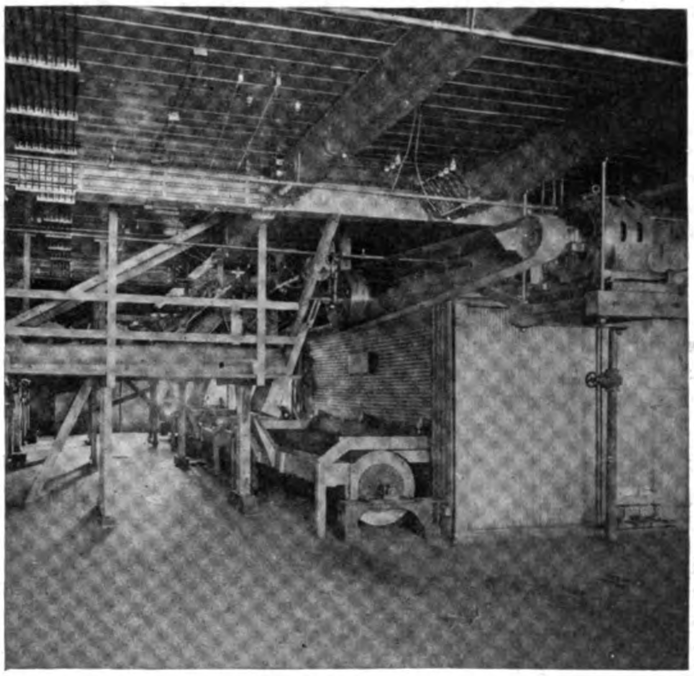
All of the cable used in the motor circuits is rubber-covered to a thickness of 3/32 in. All solid conductors are No. 2 B. & S. gauge, larger sizes being made up of small wires in the manner of standard cables. Porcelain clamp insulators without iron bands are used throughout the building. The average distance between insulators on a straight line is not over 36 ins. Where feeders or wires run through floors, porcelain floor insulators are installed projecting 2 ins. above and below the finished floor. Three feeders run from the switchboard busbars to the motor circuits on the various floors. One feeder supplies the basement, first and second floors; the second feeder supplies the third floor, and the third feeder carries current to the fourth and fifth floors.

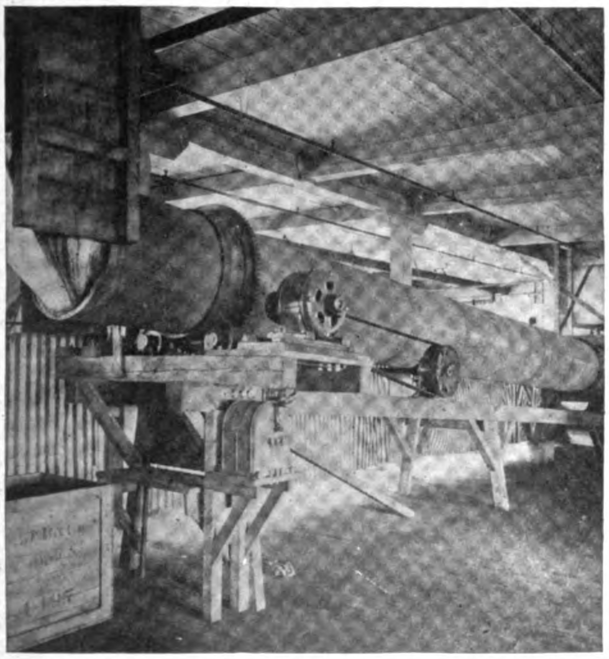
There are installed seventy 6-ampere 125-volt enclosed alternating-current arc lamps, and about 150 16-c.p. 125-volt incandescent lamps. The incandescent and arc lamps are on separate circuits. Four conductors constitute a feeder or riser. One of the four conductors is of proper size to feed one side of all the two-wire circuits; the other three conductors are one-third this size. All branch lines leaving cut-out boxes are two-wire, and equal distribution is made between the three small conductors and the large single conductor which leads out from the junction of the generator armature winding. The connections at switchboard are so arranged that distribution of direct current at night, when the motors are shut down, is effected by combining the terminals of the three small wires into a single leg and using the large wire for the opposite leg.











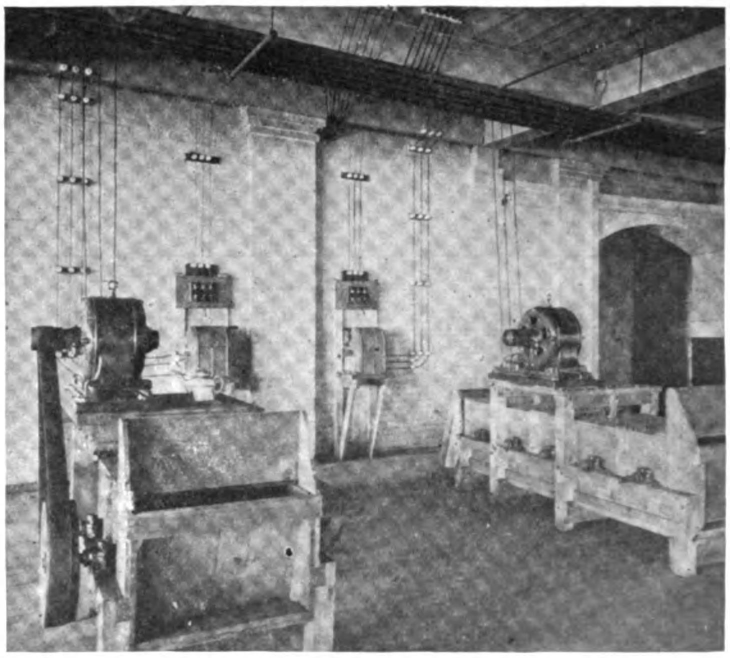


FIG. 4.—10-H.P. MOTOR DRIVING PLUG MACHINES.
FIG. 6.—10-H.P. MOTOR DRIVING FAN.
FIG. 8.—5-H.P. MOTOR DRIVING LEAF STEAMER

FIG. 5.—5-H.P. MOTOR DRIVING WRAPPER CASER.
FIG. 7.—10-H.P. MOTOR DRIVING WRINGERS.
FIG. 9.—3-H.P. MOTORS DRIVING SHAKER MACHINES.

A 5-h.p. motor drives the leaf steamer (Fig. 8), which is a sheet-iron cylinder 35 ft. long by 3 ft. in diameter. In this steamer the initial step in the process of tobacco manufacture is begun. On the basement floor a 15-h.p. motor drives a stem-baling machine, which compresses and binds the stems into the form of a bale for shipment. After the leaf is stripped of its stem it is collected in bulk and dropped through chutes to be automatically dipped, sweetened and passed through wringers on the floor below. A 10-h.p. motor (Fig. 7) drives three wringers, each of 30,000 lbs. capacity. The wringers automatically feed to the belt apron of three driers, 12 ft. wide by 132 ft. long. The belt aprons and cooling fans are driven by three 30-h.p. motors. Leaving the drier, the tobacco drops to an automatic carrier which conveys it into a Cardwell caser, an open copper-lined drum 15 ft. long by 4 ft. in diameter. The caser is belted to a 5-h.p. motor. A small air compressor driven by the same motor discharges into an accumulator, from which, at a pressure of about 35 lbs., an injector sprays the flavor into the caser.

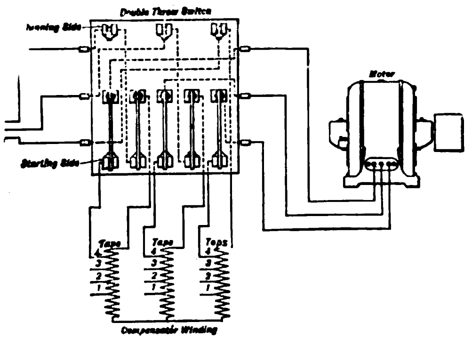


FIG. 10.—COMPENSATOR DIAGRAM.

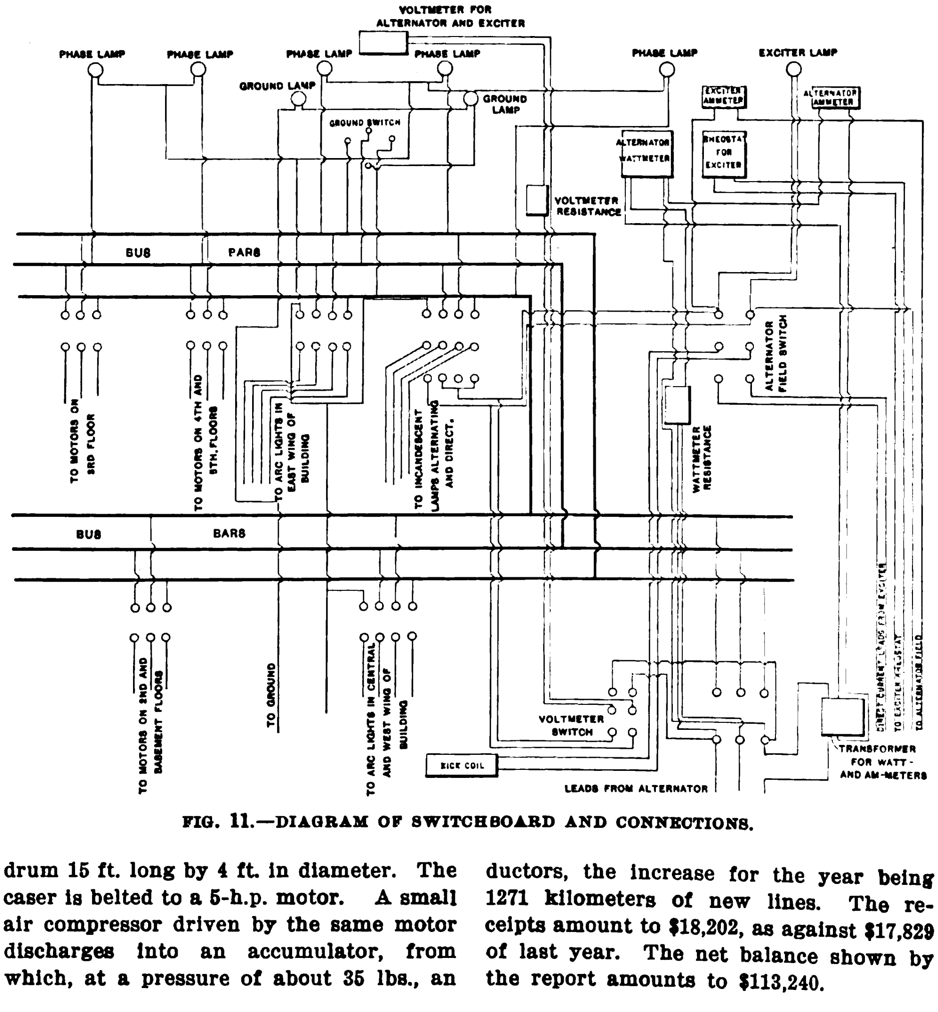


FIG. 11.—DIAGRAM OF SWITCHBOARD AND CONNECTIONS.

Two 5-h.p. induction motors drive two shaker machines, by which the flavored tobacco is loosened up. The plug machines, of the Adams duplex double-header type, are driven from two lines of shafting, belt-driven by two 10-h.p. motors. Two searching tables are also driven through a countershaft by the line shafts.

The tobacco intended for smoking purposes is put through a roller and a No. 3 Pease cutter; a 20-h.p. motor drives a shaft to which is belted the cutter and a 6-ft. grind-stone for grinding the cutter knives. After the tobacco has been cut and thoroughly dried it is passed through a granulator and sieves driven by a 15-h.p. motor. After being cased, flavored and screened in a finer mesh the tobacco is packed in bags by a packing machine driven by a 2-h.p. motor. In the twist tobacco department a fan in the dry-house is driven by a 10-h.p. motor.

The electric light and power equipment ever since its installation has shown a high figure of merit in flexibility, convenience of operation and low cost of maintenance, and the service has been uniformly and entirely satisfactory.

◆

Telephones in Buenos Ayres.—The Buenos Ayres Telephone Company has just published its annual report for 1899-1900 showing the progress made during the year under review. The telephone lines of the capital already amount to 7098 kilometers of overhead and underground conductors, the increase for the year being 1271 kilometers of new lines. The receipts amount to $18,202, as against $17,829 of last year. The net balance shown by the report amounts to $113,240.

LIFTING ELECTROMAGNETS.

BY E. B. CLARK.

The accompanying engravings illustrate the facts emphasized in the general discussion presented in the preceding articles. Fig. 3 shows a section through a magnet built on the principle of a modified horseshoe, having one pair of concentric poles. The horns on the sides are for the purpose of attaching sling chains in case of the disablement of the magnet. Fig. 4 shows a perspective of the same magnet. Though at first glance this seems to be an admirable design, as a matter of fact it was a failure in practical operation. It has the advantage of thorough protection of the winding from external injury, which is important, but it possesses the following disadvantages:

(1) Large size, and therefore low ratio of lifting power to weight. (2) A circular form of pole face, which is poorly adapted to hold a flexible piece such as a steel plate, for a long plate bends down at the ends and strips off from a round pole face. (3) Absolutely no ventilation of the winding. All heat loss in the coil must be dissipated through the outside pole or shell by conduction, and thence to the atmosphere by radiation. The winding must, therefore, be heavy to prevent overheating. (4) High leakage, due to the short distance between poles. (5) High cost of construction. (6) Necessity to take magnet apart in order to repair a broken terminal lead (the fracture in which always occurs close to or inside of the magnet).

Notwithstanding these objections, the performance of this magnet, when tested, looked excellent, on paper. It lifted over 12 tons with 13 amperes at 250 volts, or 3250 watts. Its weight was 1235 pounds, giving a ratio of weight lifted to weight of magnet of about 19.

At this point it might be pertinent to note that the lifting power of a magnet, obtained in a test where every condition is advantageous to high tractive effort, means absolutely nothing from a practical standpoint. The winding of any magnet can be so proportioned that a keeper laid across its poles cannot be detached by a pull of less than 130 to 150 pounds per square inch of pole face, provided the air gap be made small and the keeper be thick enough to carry the magnetic flux. The round magnet described above is an example of high lifting power but small practical value.

Fig. 5 shows a section through the poles and windings of a bipolar magnet in use by the Illinois Steel Company for a number of years for handling plates. Figure 6 shows a side elevation, and Fig. 7 a perspective view of the same magnet. The form of the pole face is well adapted to plate handling; when it is laid across the plate a long surface of polar face is presented to resist the first tearing-off tendency, due to the plate bending down at the ends. The pole faces being some distance apart do not encourage leakage. The magnet will pick up several plates at a time, which is an advantage when loading small sheared plates and a disadvantage when handling long unsheared plates. This magnet, however, as did the round magnet, possesses the disadvantages of large size, lack of ventilation, high first cost, and high cost of maintenance. It must be taken apart to repair a lead broken close to the frame, or to replace a worn eyebolt. The top plate is of steel, the pole pieces are of wrought iron, the casing is of cast brass, and the winding of No. 14 double cotton-covered magnet wire (two coils, 85 pounds each). On test it has lifted 6 tons with 6¼ amperes, at 250 volts, or 1562 watts. Its weight is 1200 pounds, giving a ratio of lifting power to weight of 10.

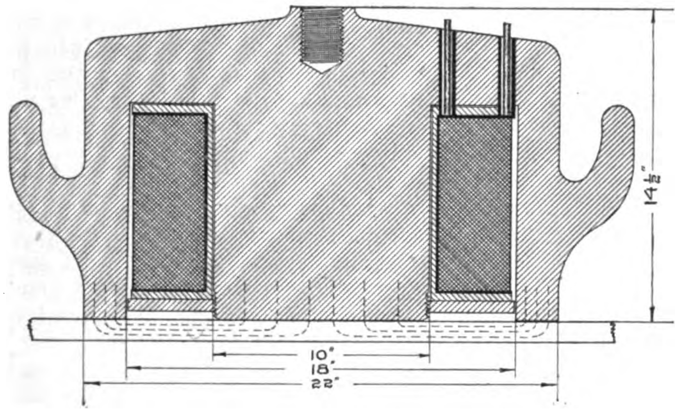


FIG. 3.—CROSS SECTION OF ROUND MAGNET.

A comparison of the data given for these two magnets makes it appear that the round magnet is much better, but, as already stated, the round one was a failure and the long one a success. The conclusion is that the figures usually given for the performance of a magnet, viz., lifting capacity and power consumption, are absolutely valueless from a practical standpoint. The coil of the round magnet has 2904 turns of wire, weighing about 217 pounds; the two coils of the long magnet contain 2952 turns and weigh about 176 pounds. The round magnet, with its compact design, can lift more than twice the load of the long one because of its greater number of ampere turns; yet it was a failure by reason of its shape. The lesson taught is that the shape must be right, the design compact, and the magnet small. With these points in view, the solution seems very simple. It merely consists in properly grouping small magnets into one complete and mechanically well-designed structure.

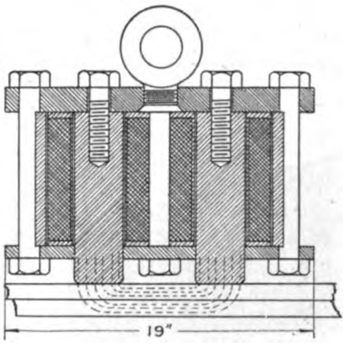


FIG. 5.—SECTION OF BIPOLAR MAGNET.

The writer, after considerable experimenting about two years ago, selected, as the best shape and best size of unit for handling plates, a pole piece having a cross-section of 1 inch by 5 inches, and a length of 3½ inches. Its coils surrounded it to a depth of ¾ in. (including insulation), and covered 2¾ inches of the length of the pole piece. No bobbin was used, the insulation of the coil being sufficient to protect it. The pole pieces were cut from 1-inch by 5 inches bar iron or soft steel and planed to true surfaces top and bottom, in groups of eight or ten at once. When the corners were rounded with a file, and the pole piece drilled and tapped for ½-inch bolts, it was finished. The coils were all alike, being machine wound and interchangeable. In the light of more recent experience this design evidently could be improved, but it is doing, and has done for two years, most successful service. Its small size (requiring small head-room) and its low weight were particularly advantageous in this case.

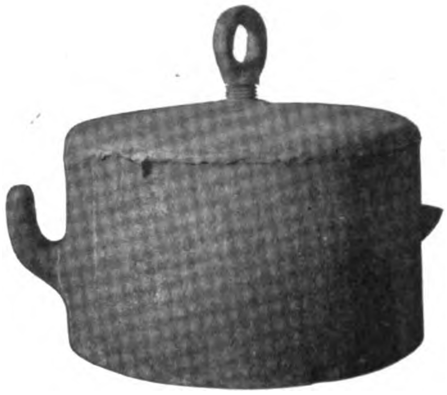


FIG. 4.—EXTERIOR OF A ROUND MAGNET.

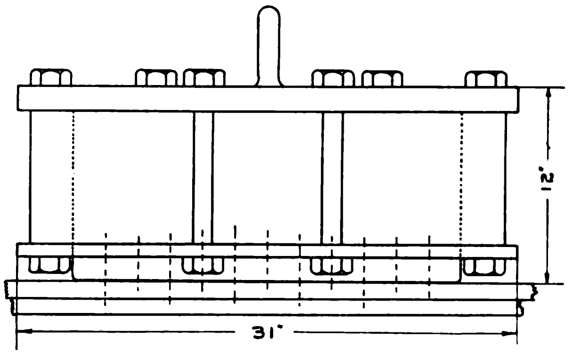


FIG. 6.—SIDE VIEW OF BIPOLAR MAGNET.

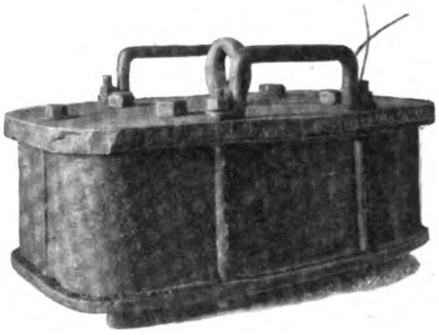


FIG. 7.—EXTERIOR OF A BIPOLAR MAGNET.

Figure 8 shows the side elevation of a magnet built up in this way. Figure 9 is an end elevation, and Fig. 10 a perspective of the same magnet. In this case the service was the handling of long unsheared plates, several magnets being hung from a long beam and operated simultaneously. It is desirable to take a very firm hold on one plate without picking up the floor plates of the "hot-bed." With this object in view, the twelve poles are arranged in two rows of six each, alternating in polarity. The magnetic flux then passes each way from each pole, the result being to reduce the reluctance of each circuit to less than it would be even if used as an independent magnet, and also to avoid carrying the density of magnetization in

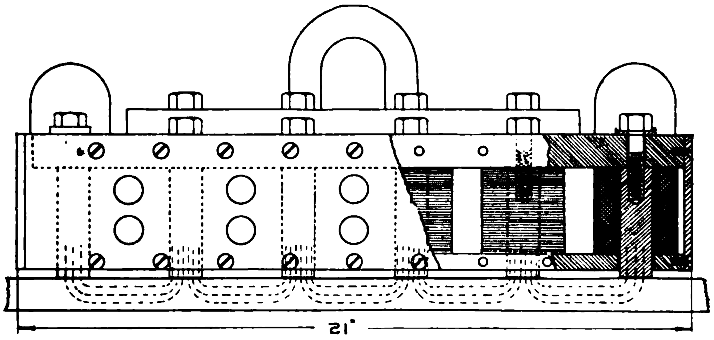


FIG. 8.—A MULTIPOLAR LIFTING MAGNET.

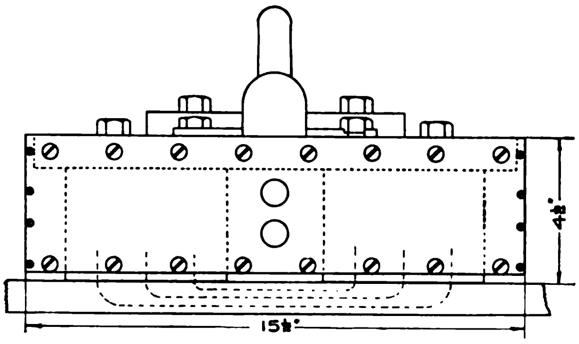


FIG. 9.—END VIEW OF MULTIPOLAR LIFTING MAGNET.

the plate being handled to an excessive point. The plate, therefore, short circuits the lines of force and prevents the leakage through to the lower side, which would pick up the floor plates. A large area of plate surface is covered and a powerful grip taken on that area.

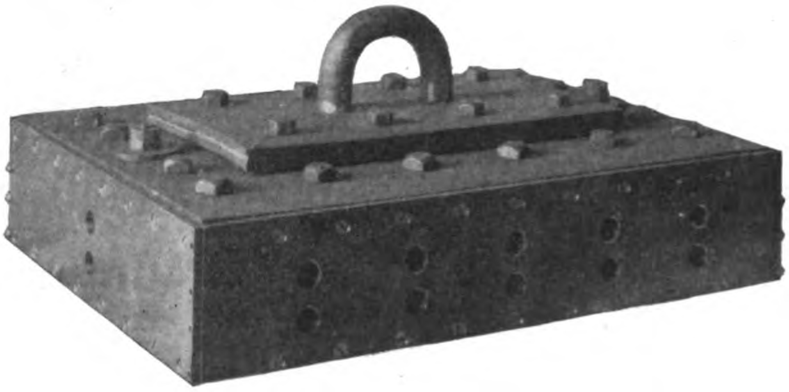


FIG. 10.—PERSPECTIVE VIEW OF MULTIPOLAR MAGNET.

The general form of the magnet face is rectangular, which is the shape best adapted to prevent stripping off. The top is one continuous piece of dead soft-steel plate, finished on the bottom and edges. Tap bolts hold the pole pieces to this plate. Above this is an eye-plate, into which the eye for supporting the magnet is riveted. By this means a worn eye can be replaced quickly and easily without disturbing the magnet proper. The terminal leads are so arranged that they cannot be broken inside of the top plate, being connected externally to terminals which are protected by cast-brass guards, easily removable. Details of this terminal are shown in Fig. 11. The coils are held in position by a bottom plate of cast or sheet brass, which, in turn, is held by side plates of sheet brass; these also afford protection to the sides of the coils. Ventilating holes allow free circulation of air through the interior. In a very wet place these holes could be omitted, but no trouble has been experienced from weather grounds where good insulation is used. The magnet weighs, complete, 300 pounds, and lifted, in a test similar to those given the bipolar magnets previously mentioned, 4 tons, making the ratio of lifting power to weight about 27. It takes 4.4 amperes at 250 volts (1100 watts), but it works with 4 amperes at 230 volts (920 watts).

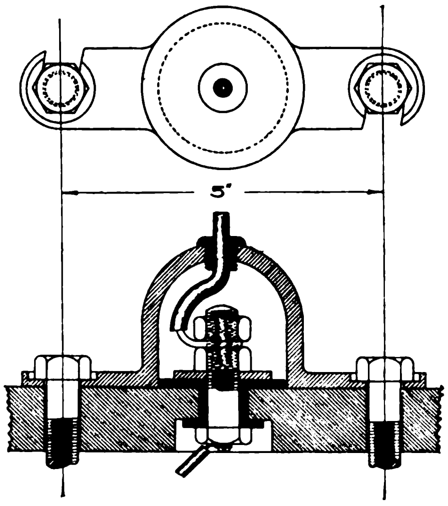
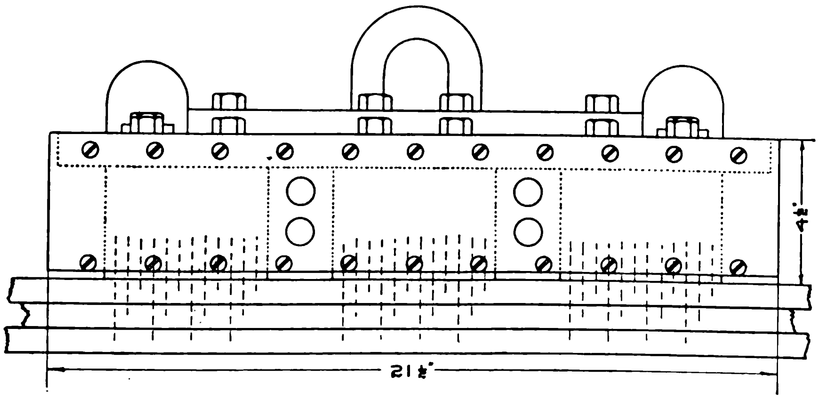


FIG. 11.—DETAIL OF COIL TERMINAL.

However, as previously stated, these figures really tell nothing of the value of a magnet for actual use. As a matter of fact, the most powerful magnet thus far described, the round type, was absolutely useless as a plate handler; the next one, also powerful, was partly satisfactory; and this least powerful one is the best in this particular case. It weighs about one-fourth as much, uses about two-thirds the power, costs about one-half as much, requires almost no repair, and holds a plate far more securely. The weight lifted per watt expended is not large, but a large figure for this ratio does not necessarily indicate a good design. In ordinary plate handling, a large air gap must be taken into consideration, which means that a large flux must be driven through a high reluctance. If this air gap be reduced to make a big lift on test, the winding will take just as much current, but the flux will not be as much per watt expended because of the decreased permeability at the high density of magnetization in the pole piece, which is above saturation. If it is desired to build a magnet which will show a big lift per watt expended, on a test, the winding should be so proportioned that the poles are not over saturated, and a large area of pole faces should be allowed. But when such a magnet is placed in use where a big air gap is unavoidable, it will suffer a severe impairment of lifting power because of the increased reluctance and consequent decreased magnetization.

To secure this high ratio of lifting power to watt expended, the current density in the coils should also be made very low; that is, a large number of turns of wire should be wound on, which will decrease the current without decreasing the ampere-turns. Of course, though, this will increase the weight of the magnet, both as to iron and copper, and will run its cost up.



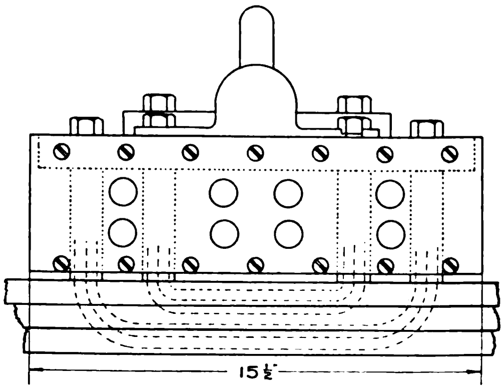


FIG. 12.—MULTIPOLAR MAGNET FOR LIFTING SEVERAL PLATES AT ONCE.—FIG. 13.

In handling sheared plates it is frequently desirable to expedite the work by picking up several small plates at once. If they are very small, say only a couple of feet square, they can be handled on edge, but if larger, they have to be picked up flat, one on top of another. A magnet for this work is built up in the same manner, but the poles are arranged differently. Figure 12 shows a side elevation and Fig. 13 an end elevation of such a magnet. The poles are arranged in four rows of three, each placed end to end. The first and second rows are close together and the third and fourth rows are similarly arranged, but considerable distance is left between the second and third rows. All poles on one side of this space are of one polarity, and all on the other side are of the opposite polarity. Then all the flux must pass over the space between the second and third rows. A plate across the magnet face then becomes saturated and some flux is forced down into the plates below. The result is that several plates are picked up. By connecting the coils in two circuits and bringing the leads out to suitable pole-changing devices, which can be made very simply, the arrangement of polarities here described, can easily be changed to the more economical one first described, for ordinary work, in which it is not desired to handle more than one plate. In the case of each magnet illustrated a plate is shown across the magnet face, and dotted lines are drawn, showing the path of the magnetic flux through the lifted plate. If it is desired to drop a plate from the bottom it can easily be accomplished by the method of quickly opening and closing the circuit, as described in the previous article. In the case of a magnet winding built up of small coils, the flashing is less severe upon opening the circuit.

There are many other arrangements of these small pole units that could be made to meet special requirements. For example, a circular structure would be well adapted for car wheels, while other special shapes to be lifted might require other arrangements. For a straight pull the round pole piece is preferable because it can be wound with a given number of turns with the least amount of wire. The table herewith gives the data for the designs illustrated.

DATA FOR THE DESIGNS ILLUSTRATED.

Type of magnet	Round, Fig. 4.	Long, Fig. 7.	Small, Fig. 10.
Size of wire	No 12.	No. 14.	No. 17.
Turns per coil	2,904	1,476	644
Total turns	2,904	2,952	7,728
Total pounds of wire	217	176	57
Total resistance at 50° C	19.25 ohms.	40 ohms.	56.6 ohms.
Amperes at 250 volts	13	6.25	4.42
Circ. mils per ampere	502	656	465
Total ampere-turns	37,752	18,450	34,158
Amp.-turns per sq. in. of pole-face	482	348	1,138
Area of pole faces, sq. in	204	106	60
Area of magnet face, sq. ins.	380	233	241
Tons lifted on test	12	6	4
Weight of magnet, lbs	1,235	1,200	300
Pounds lifted per pound of magnet	19.4	10	26.7
Pounds lifted per watt	7.4	7.7	7.5

The actual mathematical equations for predetermining the flux and the consequent required magnetizing force are very simple, inasmuch as no actual work is done by the magnet. Its function is simply to resist the force of gravity, and does not involve a space acted through. Therefore, all power absorbed by the magnet is accounted for by losses in the magnet itself. The important feature of design, then, is the correct shaping of the magnet to the work required of it, due attention being paid to first cost, and cost of repair. It always should be borne in mind that a magnet must be built to suit conditions in order to obtain best results. When this is done and a successful design produced, the owner will value his magnet at many times its cost, and generally will investigate the feasibility of putting in more of them. Like every other labor-saving device, a magnet, to be entirely successful, will often necessitate some changes in former methods of operation, but such changes are soon paid for.

The Illinois Steel Company, in this country, and one or two concerns in England, have had magnets in use for a long time, and during the last few months a number of other mills in this country have adopted their use. Where they have been properly built to suit the existing conditions they have been universally successful.

That this field, like every other one promising cheaper methods of doing work, will soon be invaded, cannot be doubted by anyone who has seen the advantages to be gained in many cases by the use of electro-lifting magnets.

◆

METHOD OF MEASURING THE VIBRATION OF A TRANSMITTER DIAPHRAGM.

BY W. L. MERRILL.

The following method of measuring the vibration of a telephone transmitter diaphragm has been tried at the University of Maine (Orono, Me.), and found to give quite accurate results. A silvered mirror, M, Fig. 1, cemented to a steel pinion, J, set in watch jewels, reflects a ray from a source of light, L, on the screen, S. Perpendicular to the pinion and in the plane of the mirror is fastened a steel arm, K, graduated to hundredths of an inch and adjustable by the screw, I. To the center of the diaphragm, D, is soldered a needle, P, which bears against the steel arm, K. The slightest vibration of the diaphragm is transmitted through the needle and arm to the mirror, causing it to oscillate and thus causing the reflected light ray to travel on the screen, S, as from A to A′. A magnet, NS, is placed behind the arm, K, to retract it, when the diaphragm recedes. Any inertia effect due to the mechanism may be equalized by adjusting the damping spring, F, until the transmitter works normally.

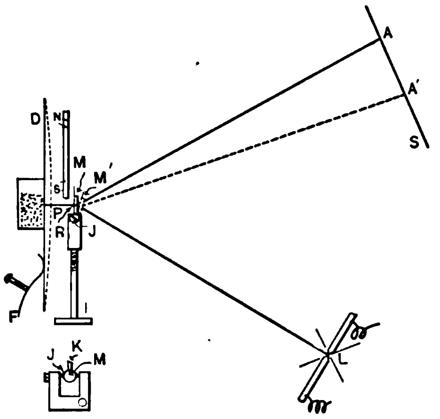


FIG. 1.—MEASURING THE VIBRATION OF A TRANSMITTER DIAPHRAGM.

The travel of the light ray on the screen bears a direct geometrical relation to the travel of the mirror, and hence gives a basis for measuring the magnitude of the vibration of the diaphragm. The calculations based on experiments performed with such an instrument gave a diaphragm excursion of 1/3000 in., where the distance from J to R was 1/10 in., that from R to B 25 ft., and the travel, A, A′, 2 ins. The ticking of a watch gave a noticeable deflection, while sounds of greater intensity caused deflections on the screen of almost 2 ft.

◆

BOILER FEEDING AND FEED-WATER HEATING.

BY L. B. MATHER.

The operation of getting water into a steam boiler is so closely interlinked with the operation of heating it that it is scarcely practical to consider the two separately. It is unnecessary to point out the saving obtainable from heating the feed water; this is amply and strikingly demonstrated by the fact that using live steam to heat the feed water before it enters the boiler is more economical than putting it in cold. But it is frequently perplexing to determine just what method of heating and what means of delivering the feed water will be most economical. The first cost of the apparatus considered enters into the question, of course, as the interest and cost of maintenance form part of the operating expense of the plant, and the class of help obtainable must also be considered, simplicity frequently being preferable to economy.

Speaking generally, it is safe to assert that for all plants of a size too small to justify the installation of economizers, it is good practice to employ heaters in the exhaust pipes of the engines, absolutely regardless of the condensing question. If the plant be non-condensing, it is a self-evident proposition that exhaust-steam heaters are imperative; even if the exhaust steam be used for heating purposes, it will usually pay to put in a heater between the engine and the heating system, taking care, of course, that the steam shall not be robbed of so much heat as to make it useless for radiator service. In such a case, still speaking generally, it will probably be advisable to use some form of steam pump for boiler feeding, in order that the exhaust from the pump or pumps may be utilized for further heating the feed-water in secondary heaters.

It goes without saying that the pump to be used should be of the highest efficiency possible. Ordinary simple direct-acting steam pumps require from 100 to 150 lbs. of steam per horse-power-hour; compound pumps of this type require 60 to 90 lbs.; simple fly-wheel pumps, which are really pumping engines on a small scale, may be had that will develop a horse-power on 50 lbs. of steam an hour; a compound fly-wheel pump requires 30 to 50 lbs. of steam per horse-power-hour. The writer once ran across an odd type of small pumping engine which had one water and two steam cylinders mounted side by side, all three being single acting. There was a single valve between the two steam cylinders which cut off the steam at one-third stroke, no variation of cut-off being provided; the speed was regulated by means of a globe valve in the steam pipe, just as the ordinary direct-acting pump is controlled, and it showed the remarkable economy of 38 lbs. at full load and 45 lbs. at two-thirds the normal speed. The only reason that can be conceived for the failure of this "freak" pump to become an important factor in the market was the cost of building it.

To revert to the specific subject under discussion: In non-condensing plants where the exhaust steam from the main engines is wholly available for heating the feed water, it will generally be found advantageous to employ electrically-driven boiler-feed pumps for regular service and to provide a single auxiliary steam pump for use at such times as the electrical equipment may be shut down. A good non-condensing engine will deliver a horse-power on 28 pounds of steam an hour, and a decent generator will convert this power with an efficiency of 93 per cent; the losses in a motor-driven pump should be somewhere near 40 per cent—say the combined efficiency of the generator and the motor-pump is 56 per cent; then the pump will deliver a horse-power on 50 pounds of steam an hour, which compares with an unusually good compound direct-acting steam pump or a simple fly-wheel pump. Considering simplicity, therefore, as well as economy, the motor-driven pump is preferable, as a fly-wheel pump is a much more complicated mechanism, besides requiring a considerable amount of small piping which has extravagant radiating surface. It seems entirely justifiable, therefore, to say that electric motor-driven pumps are preferable to either of the other types under average conditions for boiler feeding in non-condensing plants where the feed water can be sufficiently heated by the engine exhaust.

In condensing plants, primary heaters will be found advisable under average conditions. Of course if the plant is a very large one, economizers claim consideration, but in a plant of ordinary size an economizer is usually barred by the cost of installation and attention. A primary heater will bring the feed-water temperature from 40 or 50 up to about 110° Fahr.; a higher temperature could be secured by imposing back pressure on the engine, but this is obviously not good practice with a condensing engine. It will be advisable, therefore, to still further heat the feed water by passing it through a secondary heater after it leaves the primary heater. If sufficient heat can be obtained from the exhaust steam of the air, circulating and boiler-feed pumps to carry the feed-water temperature up to about 200° Fahr. without deliberately using pumps of low efficiency for the sake of their exhaust heat, then the combined exhausts from all the pumps should be passed through the secondary heater.

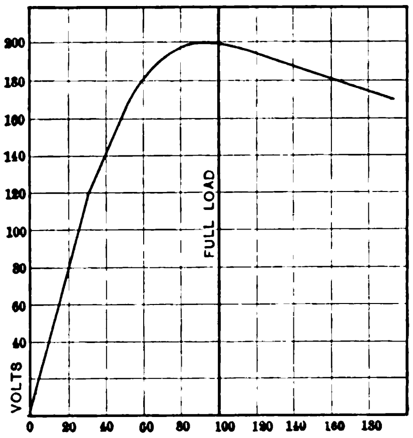
If, however, the efficiency of the auxiliaries is so high that a gain of only 40 to 50 degrees in temperature is obtainable in the secondary heater, it will usually be advisable to run the pumps condensing, still passing the exhausts through the secondary heater in order to extract as much heat as possible before delivering to the condenser, and to reinforce the secondary heater with live steam bled from the receiver or the high-pressure exhaust of the engine. If the engine is provided with a reheater which superheats the receiver steam, then the steam used in the secondary feed-water heater should be taken out from the high-pressure exhaust before that steam reaches the reheater, in order to avoid a waste of superheat. The plan outlined would be almost universally more economical than to sacrifice the efficiency of the pumps in order to obtain sufficient heat from their exhaust steam to give the feed water the proper temperature. Air and circulating pumps should preferably be engine-driven, but whether they are of this type or are ordinary forms of direct-acting pumps, they should be run condensing unless their exhaust steam added to that of the boiler feed pumps will supply sufficient heat for the feed water without bleeding the engine receiver.

Belt-driven pumps are not, as a general rule, commendable for boiler feeding on account of their inefficiency at partial loads when driven at constant speed, as they would have to be in all modern central stations and isolated plants. If it were practical to vary the speed of the pump according to the requirements of the boilers, without interposing a lot of power-consuming gear, the belted type would show the highest efficiency of any form of boiler feeder.

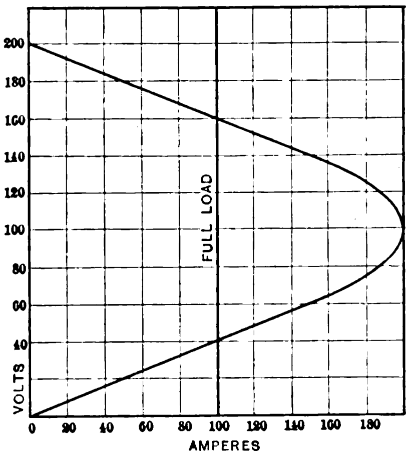
RELATION OF CHARACTERISTIC CURVES OF DIRECT-CURRENT DYNAMOS TO PARALLEL OPERATION.

BY ALTON D. ADAMS.

The action of direct-current dynamos in parallel may be predicted, to a large extent, from their characteristic curves. For this purpose, curves should be constructed showing the voltages at dynamo terminals, on one set of ordinates, and amperes in external circuits on abscissae at right angles to the ordinates plotted to some convenient scale. Such curves are here shown for series, shunt, evenly compounded and over-compounded dynamos. The curve for the series dynamo is from a machine with capacity of 100 amperes at 200 volts, maximum, that part of the curve between the zero point and the full load line covering the total intended range of work. If the resistance in the external circuit of the dynamo is decreased so that more than 100 amperes flow through the armature and magnet coils, the voltage of the dynamo drops as shown by the curve, which will reach the zero line of pressure when the dynamo is on a short-circuit of no appreciable resistance. The internal ampere flow of the series dynamo is greatest when the external voltage is zero.



CHARACTERISTIC OF A SERIES DYNAMO.

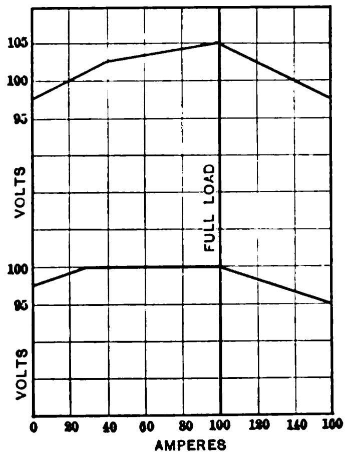


CHARACTERISTIC OF A SHUNT DYNAMO.

The characteristic curve of a shunt-wound dynamo shows some properties that are exactly opposite to those of serise-wound machines. With no current in its external circuit, the series dynamo has no voltage, save the very small amount resulting from the residual magnetism of its frame. On the other hand, a shunt dynamo, as shown by its curve, has the maximum voltage with no current in its external circuit. When the circuit of a series dynamo is closed, its pressure rises with the flow of current; when the circuit of a shunt dynamo is closed the voltage at its terminals drops with the increase of current flow. If the external circuit of a shunt dynamo is reduced so as to allow a flow of current beyond the full load capacity of the machine, the voltage continues to drop for each increase of current, until the external resistance reaches a certain value for each dynamo, corresponding to the maximum ampere output for that machine. Any further reduction of the external resistance results in a fall of both the volt and ampere output of the dynamo, which are brought to zero when the external resistance is zero.

These results are plainly indicated by the shunt dynamo curve shown herewith and may be foreseen from the fact that an external circuit of no appreciable resistance, being in parallel with the shunt magnet winding of high resistance, allows no current to pass through it, and there is only a minute amount of residual magnetism to induce e.m.f. in the armature. If two shunt dynamos having equal voltages on open circuit are connected in parallel on a load not greater than their combined capacities, the curve shows that any inequality of load between them will tend to decrease rather than increase, since the dynamo loaded to the larger part of its capacity will tend to drop in voltage, while the dynamo loaded to the smaller part of its capacity will tend to rise in voltage, the combined tendency being to properly divide the load.

The curve of the compound-wound dynamo shows the combined effects of its shunt and series coils. At the start, with no current in the outside circuit, the dynamo reaches nearly its full voltage, unlike the series-wound dynamo, which has no material voltage until its outside circuit is closed, and unlike the shunt-wound dynamo, which gives its maximum voltage on open circuit. The curve of the compound-wound dynamo rises slightly at the start of current flow in the outside current, but as the saturation of the magnets increases, the contrary effects of the series and shunt coils soon reach a point where they just balance each other, if the dynamo is evenly compounded. For the greater part of its capacity the compound-wound dynamo gives a characteristic curve that is nearly a straight line, but soon after the point of full load is passed, the curve begins to drop toward the line of zero e.m.f. This drooping curve is similar to the first part of the shunt-dynamo curve; but differs from the second half of that curve in that it does not tend toward the zero point of both pressure and current; on the contrary, it follows the general course of that part of the series-dynamo curve beyond the full load line, tending to a very large current on short-circuit.



CHARACTERISTICS OF COMPOUND DYNAMO.

If two similar compound-wound dynamos be connected in parallel without an equalizer and given a load less than the sum of their capacities, the curve shows no such tendency to mutual adjustment as is evident in the characteristic curve for shunt dynamos. Any increase of load on either dynamo does not tend to lower the voltage of that dynamo, but may tend to lower the voltage of the other dynamo, especially if its load falls quite low, and this acts to further increase the differences of load. Adding the equalizer connection, of course, changes this. Any increase of the current in either armature beyond the flow in the series coil of its magnet will leave this dynamo under-compounded, and its characteristic curve will show a drop in pressure for the increased load, like that of a shunt dynamo. Meantime the dynamo, with a smaller current flow in the armature than in its series coil, is for the time over-compounded and consequently tends to increase its e.m.f. and check the unbalancing process.

If the characteristic curves of compound-wound dynamos do not show a nearly equal compounding action, an equalizer connection will not make them work well together.

Convention of the Northwestern Electrical Association.

The ninth annual convention of the Northwestern Electrical Association was held on Wednesday, Thursday and Friday, January 16, 17 and 18, at Milwaukee, Wis. After calling the convention to order, the president, Pliny Norcross, delivered the annual address, which was received with enthusiastic applause and for which a vote of thanks was tendered to him.

In the course of his address Mr. Norcross discussed municipal lighting at considerable length, and expressed the opinion that as municipal ownership becomes more fully understood the desire for it will diminish. A committee appointed by the National Association of Officials of Bureaus of Labor Statistics in the United States, he said, had made a report on this subject which contained many interesting facts. In one municipal plant there were eight private arc lamps of 1200 candle-power and 10 street lamps. The users of the eight private lamps were obliged to pay the city 12 cents per kilowatt-hour, while the city paid nothing for its 10 street lamps. In other words, a few enterprising citizens paid for their own light five or six times as much as they would have paid to a private lighting company, and carried the entire burden of lighting the entire city's streets, which should have been borne by all of the taxpayers. In another plant the cost to the city of operating 75 street lamps was over 12½ cents per kilowatt-hour. In contrast to this a private company was mentioned which furnishes the city and private users light at the uniform rate of 2½ cents per kilowatt-hour. Mr. Norcross closed his address by presenting to the convention a copy of a bill that has been introduced in the United States House of Representatives, the object of which is the conversion of the present Bureau of Weights and Measures into a National Standardization Bureau.

The report of the secretary and treasurer was then made, which covered the entire year's work of the Association since the convention of last January. Applications for membership were presented, and E. L. Debell, chairman of the Legislative Committee, presented his report. In this report Mr. Debell stated that a bill had been presented to the Wisconsin Legislature having as its object the appeal of the present license fee or percentage tax imposed on electric light and power companies. He stated that the tax commissioners in a partial report made to the Legislature had recommended an increase in the license fee, proposing that all companies should pay 3 per cent license instead of 2 per cent where the gross receipts of the company do not exceed $50,000, and where they do exceed $50,000, 1/10 of 1 per cent to be added for each $7,500 of additional income. Mr. Debell stated that the Association's committee had done all that was possible toward persuading the tax committee to retain the present license fee of 2 per cent, and that the only thing left to be done was to appear before any legislative committee which might be appointed for the purpose of considering the matter.

The committee's report was adopted and the committee was continued for further work. The applications for membership were then referred to the proper committee for classification and report to the Association, and letters were read; one from H. W. Frund announcing his inability to attend the convention, one from Henry J. Doherty also expressing his regret at his inability to attend the convention, and suggesting that the Association might advantageously consider the question of three-phase distribution for light and power; and one from the E. P. Allis Company, extending an invitation to the delegates to visit its engine works. After some further routine business a paper from Mr. Doherty was read by Mr. Debell, the subject being

A METHOD OF CHARGING.

Mr. Doherty pointed out that an analysis of flat rates would show a definite charge for a fixed capacity, regardless of the quantity of current used between the limits of no service and constant maximum consumption. Dividing the fixed rate by the maximum consumption under such an arrangement would give the minimum rate per unit of service. An analysis of meter rates would show a fixed charge per unit of current sold, regardless of the capacity demanded. In this case the cost of production at the station would vary from a very low figure per kilowatt-hour if the total capacity were used continuously up to infinity if no current were used. In the abstract, flat rates are preferable but both systems, Mr. Doherty said, seem almost absurd. Theoretically, flat rates can be placed sufficiently high to protect the station from loss, but such rates would drive away much profitable business. Meter rates cannot be placed high enough to prevent loss. Even if the consumer agrees to pay $1 per kilowatt-hour his consumption may be so small that his bill will not equal the cost of reading his meter, keeping books for his account, the core loss of his transformer capacity, and the loss in the meter.

Mr. Doherty cited the practice of a central station with which he was familiar to illustrate the worth of different consumers supplied on a meter basis. A minimum charge of $1 a month was made whether current was used or not. This means a minimum of $1 per lamp per month if the consumer has only one lamp, and 1 cent per lamp per month if the consumer has 100 lamps. At this particular station the average annual bill is $1.96 per lamp; the minimum yearly bill per lamp is 24 cents, and the maximum yearly bill per lamp is $38.46. Assuming that the station represents an investment of $20 per lamp capacity, the length of time necessary for the gross revenues to equal the investment would be ten years and two months for the average consumer; 83 years and four months for the minimum consumer, and only six months for the maximum consumer. If the entire amount paid by the minimum consumer were clear profit the station would be earning only ¼ of 1 per cent on the investment. [This is evidently an error in transcription as 24 cents a year is 1.2 per cent interest on $20.]

A charge of a fixed rate per kilowatt-hour on the meter basis, Mr. Doherty continued, bears no relation to the cost of service. Suppose you should receive an application for a 2000-light connection from an isolated plant to be used only in case of a breakdown, at what rate per kilowatt-hour could you afford to supply the plant with service? The same problem confronts us on a modified scale in the case of each central station consumer. There are certain costs, such as bill-making and meter reading, which are entirely fixed by the number of consumers or meters, and many other costs are virtually fixed by the number of consumers or meters to be cared for, such as meter testing and maintenance, office rent, complaints and gratuitous work, superintendence and inspection. To cover such expenses as these, Mr. Doherty proposed to have a fixed charge for each consumer, regardless of his consumption or the size of his installation, provided no more than one meter is installed.

To cover certain other costs which are fixed by the capacity demanded, such as interest on investment, transformer losses, maintenance, depreciation, etc., Mr. Doherty would make a fixed charge for each lamp the consumer's connection will permit him to demand, without regard to the number of lamps installed, or amount of current used. To cover expenses which vary with the amount of current delivered, such as coal and lamp renewals, a uniform rate per kilowatt-hour should be charged in addition to the preceding fixed charges.

A charge for "readiness to serve" fixed on this basis, and a low kilowatt-hour rate, will bring about many advantages to the central stations, and protect them from loss, unprofitable patronage, and will also probably protect them from undesirable legislation. In view of the fact that it will be inadvisable to enforce this system on old consumers who will be injured by its adoption, Mr. Doherty proposed to adopt it first as a substitute for all special rate consumers, and also for new consumers. Instead of dividing expenses as they exist to-day and apportioning them among the consumers on this basis, the author expected to adopt such charges as will benefit long hour, and therefore profitable, consumers to such an extent as can be readily compensated for by the additional business which can be secured with a lower rate per kilowatt-hour.

In one station where experiments along this line have been made, it had been found more profitable to supply consumers on this rate system, making a fixed charge of $6 per consumer per year, plus $1.80 per lamp demanded per year, to which is added 4 cents per kilowatt-hour for current used, than to sell at a straight rate of 10 cents per kilowatt-hour. It is needless to call attention to the fact that consumers will be much more liberal in the use of current when supplied at 4 cents than at 10 cents per kilowatt-hour. Mr. Doherty advised making all contracts for a year or more, allowing the consumer to contract for any capacity he may choose; the capacity to be increased whenever he desires, but not to be decreased except at the expiration of the period contracted for; the capacity to be limited by a suitable maximum demand cut out to prevent him from demanding more capacity than he contracts and pays for, and one-twelfth of the fixed charge to be included in each monthly bill. Following Mr. Doherty's paper was one by Mr. Loren W. Burch on

PRACTICAL LINE CONSTRUCTION.

In his paper Mr. Burch pointed out the vital importance of allowing only the very best of line construction. The poles, he said, should be well peeled, dressed up, housed and gained. One, two or even more extra gains should be cut while the pole is down, as it is much easier and more cheaply done on the ground. A pole well set and tamped is half guyed. No matter how good your poles may be or how straight the line in which they are set, if they are not properly guyed the result will be a poor piece of work. It is safe to say that properly guying a line will enhance its value fully 50 per cent.

Mr. Burch disapproved of hand-twisted guys. Machine-twisted guys are cheaper, stronger and more easily handled. Guy clamps should be used in all cases, as it permits of coming up with the end and taking the slack out of a guy, if necessary, without cutting it. Guy rods are better than ungainly-looking posts and should be used wherever possible. All guy wires should be fitted with circuit-break knobs placed at a distance of 6 to 8 ft. from the pole end to render the lower part of the guy wire harmless. Guying to trees, buildings, etc., should be avoided absolutely. In the construction of the ordinary plant the subject of guying is an after consideration and if a guy is put up one end is made fast to the pole and the other to some man's house, barn or tree. This is bad practice, even if the permission of the owner is granted, as the ownership of these buildings may be changed at any time. Special attention should be paid to all corner, junction and end poles or there will be no end of trouble when the lines are pulled up taut.

Cross-arms are made in standard sizes and spacings of not less than 18-in. centers and 17 ins. between pins, should be used on all lines carrying 1000 or 2000 volts. Cross-arms should be doubled on all corner, junction or end poles. On 6 and 8-pin arms 9/16 x 9-in. lag screws should be used, and cross-arm braces not smaller than ¼ x 1¼ x 26 ins. The use of galvanized iron throughout is all right, but it is not absolutely necessary in all cases. It depends upon the color the poles are painted. Cross-arm braces should be used on all cross-arms over 3 ft. long and on two pin arms if a heavy wire is carried upon them.

Cross-arming poles is a very particular part of the construction of a good pole line. Great care should be taken to see that the gains are not cut too large in the poles, thus allowing the cross-arms to wabble. The lag screws should be driven in only far enough to give them a start and screwed in the remainder of the way. Cross-arms should be put on the side of the pole opposite to the strain so that they will not be pulled off. In double cross-arming, holes should be bored through the spacing blocks and these should have precisely the same thickness as that of the pole at the gain, so as to prevent bending the cross-arm.

Good live-oak pins are all right to use on straight runs or light wires, but on corner or junction poles locust pins should be used. For wires from No. 8 down to No. 0000 it would be better construction to use iron pins.

Stringing wires over buildings is bad practice, as you are liable to damage the roofs over which they pass. For instance, it is customary to build a "horse" to support a roof line and in time the water will collect and rust the tin under the legs. Leaks result, the water causes damage to the building and its contents, and the owner brings suit.

Mr. Burch pointed out that it was much more economical in streets which were lined with trees to use extra long poles so as to keep the line entirely above the tree tops. This, he said, though a little more expensive in first cost, was considerably more economical in maintenance than a pole line running through tree leaves, which necessitated cropping trees and involved all sorts of trouble with property owners. He also pointed out in conclusion that no line construction should ever be done hurriedly or with a view to temporary use. In laying out new lines it is better to run them with a view to getting future business rather than to take the shortest route to the consumer already obtained. He strongly urged the setting of poles in alleys and on lot lines whenever possible, and the feeding of buildings from the rear.

In the discussion which followed the reading of Mr. Burch's paper George Cutter emphasized the necessity for doing work of only a permanent character, and pointed out that the day had gone by in electrical construction for rushing out work in any sort of fashion and trusting to improving it and beautifying it afterward. There is not a station manager here, he said, who would think for a moment of having his steam pipes leak all over the plant, shoveling more coal under the boiler to make up for the leaks, but he will go outside where there is 10 per cent leakage loss in his lines and pay no attention to it. Regarding the question of insulating guy wires, Mr. Cutter agreed with Mr. Burch that every guy wire should be insulated at the top. He cited a case in which a man was injured by taking hold of the steel hanging cable of an arc lamp, and said that the company in whose plant this occurred has now adopted the practice of inserting a circuit-break insulator in the steel cable as high as possible above the windlass, and thoroughly grounding the windlass. After some desultory discussion of the license tax and the methods of encouraging the discussion of papers the session was adjourned.

The Thursday session was called to order at noon. Several applications for active membership were presented and acted upon favorably; and a communication was read by the secretary from the Jamestown (Ohio) Electric Light Company asking for information concerning a high candle-power gasoline lamp which seemed to have been threatening a serious competition with the company's arc lamps. The letter started quite a discussion on gasoline street lamps. George Cutter expressed the opinion that the lamp referred to was probably a group of Welsbach burners made especially heavy and supplied from a gasoline holder above the lamp, and said that but for the annoyance of starting these lamps electric light companies would find them a serious competitor. Mr. Strong, of Baraboo, said that his arc-light interests had been somewhat threatened by these gasoline lamps, of which there were about 30 in the outskirts of the town. He said that in this case there was one large Welsbach burner on each post using gasoline, and stated that the small self-generators used in connection with these lamps soon destroyed themselves, and that their operation was not profitable. The very best Welsbach lamp will not give more than 60 candle-power when it is new, he said, and deteriorates much more rapidly than an incandescent lamp; moveover, when the weather changes the proportions of air and gasoline change, so that while a Welsbach lamp is a nice thing indoors it must be entirely different from the arrangement at present used to be satisfactory out of doors.

Mr. Gille said that the burner referred to in the Jamestown Electric Light Company's letter was probably the Kern burner, which was being introduced and pushed very hard in this country. He said that his company had felt the effect of the burner in a commercial way to some extent, and he thought the matter was of sufficient importance for consideration. Mr. Debell said that several attempts had been made in Sheboygan to introduce gasoline burners of the Welsbach type, but that none of them had succeeded. Mr. Lord, of Waupaca, said that there was no city gas in his town so that it was either a question of electric light or kerosene. A couple of years ago a party came there to introduce Welsbach gasoline lamps and got permission to install a plant for experimental purposes in one of the stores; the third night the thing exploded and the electric light business has been first-rate ever since. There are still no gasoline burners in Waupaca.

At the close of this discussion the committee on the summer meeting made its report, recommending that the next summer's convention be held in the last week of June at Sheboygan, Wis. After considerable discussion the committee's report was adopted and Sheboygan approved as the place at which the summer meeting is to be held.

Prof. W. E. Goldsborough, of Purdue University, then read a paper on "Synchronous Converters" in which he explained the principle and operation of rotary converters. He presented a table showing the comparative capacity ratios of different types of synchronous converters, which is given herewith:

COMPARATIVE CAPACITY RATIOS OF DIFFERENT TYPES OF SYNCHRONOUS CONVERTERS.

	Direct Current.	Single Phase.	Three Phase.	Two Phase.
Volts between adjacent brushes.	1	.707	.612	.5
Amperes per wire	1	1.414	.944	.707
Ratio of armature copper loss in rotary converter to copper loss of same machine operated as a direct current generator at the same output.	1	1.37	.555	.37
Relative capacity of rotary converter, and same machine operated as a direct-current generator at the same temperature	1	.85	1.34	1.64

The figures given in the table, Prof. Goldsborough explained, were based on the assumption that the currents followed the sine-wave law. A two-phase alternator giving a wave that is comparatively flat with a fairly sharp peak in the center would have a higher e.m.f. ratio than the value in the table. A paper was next read by Mr. P. D. Wagoner under the title of

THE SERIES INCANDESCENT LIGHTING SYSTEM OF THE FUTURE.

Mr. Wagoner pointed out the advances that had been made in the development of the enclosed-arc lamp, and also pointed out that in the central sections or business portions of any city where a considerable volume of light is necessary arc lamps of the greatest illuminating power are required, but as one passes from these districts toward the outskirts the volume of light required is less and less the farther out one goes, until a district is reached where the amount of money to be expended per unit of area illuminated must be considerably below that which is justified in the more densely populated districts. In such a sparsely populated district it would obviously be more satisfactory to use a greater number of lights of lower intensity, as such lights may be placed closer together than would be possible with an expenditure of the same amount of money for lights of greater intensity; consequently, for such a territory the use of a low candle-power source of light, such as incandescent lamps, is advisable.

Considering reliability of operation, Mr. Wagoner presented tests recently made by W. D'A. Ryan, of Lynn, Mass., on fourteen Welsbach street lamps rated at 80 candle-power each. The result of these tests is given in the accompanying table.

WELSBACH BURNER TEST RESULTS.

Mantle Number.	No. of chimneys broken.	Hours run to end of life.	Hours run of mantle to fall to 80% of 80 candle-power.	Hours run of mantle to fall to 80% of 60 candle-power.	Initial candle-power.	Candle-power at end of life.
1	1	418	110	....	70	61
2	1	1069	110	810	71	40
3	4	440	50	....	69	60
4	4	338	90	....	70	67
5	1	129	.	....	60	56
6	3	18	...	....	63	67
7	1	16	...	....	35	35
8	2	109	40	....	66	61
9	1	21	...	....	69	69
10	0	674	175	....	64	58
11	5	420	140	....	76	50
12	1	336	15	....	66	54
13	1	973	160	710	72	39
14	1	451	120	....	73	51
Avg.	1.85	388.7	72.1	109	66.3	54

The tests, Mr. Wagoner explained, were made under laboratory conditions which it would be impossible to duplicate in actual service. The lamps would be subjected to drafts and vibrations and it would be impossible to regulate the gas pressure accurately, as was done during the tests; so that the result of the tests is better than could be expected in practice. Mr. Wagoner pointed out that although the average candle-power of the Welsbach burners which were tested was 66 there was a variation between 60 and 75 candle-power in individual lamps; incandescent lamps showing such a variation in candle-power would not be considered by any lighting company. The author also described some comparative tests of the illuminating power of Welsbach burners rated at 60-c.p. and 50-c.p. incandescent lamps made by W. D'A. Ryan.

A photometric screen was constructed, and a number of cards were printed, having sentences in eight different sizes of type. This instrument was mounted on a tripod midway between the incandescent and Welsbach lamps, which were 200 ft. apart. Each one of seven people took readings of the cards placed in this screen, the object being to read the smallest type possible. It was possible to read type two grades finer with the light from the incandescent lamp than with that from the Welsbach mantle. The next observation gave a more definite idea of the relative illuminating values of the two lights. A given size type was selected and, lining the light up on the center of the card, the observer walked backward until the selected type could be read. When this point was reached, the distance was measured to the lamp. The average results were that the type could be read 150 ft. from the incandescent lamp and 122 ft. from the Welsbach lamp. As intensity of light varies inversely with the square of the distance from the origin, the relative illuminating powers of two lights will be in the ratio of the square of the distance to point of equal illumination, or in this case, 150^2 to 122^2 or 1 to 1.5—the 50-c.p. incandescent lamp, therefore, had 1½ times the illuminating power of a nominal 60-c.p. Welsbach burner.

The foregoing conclusions are based on the actual photometric candle-power of the incandescent lamp and the nominal candle-power of the Welsbach lamp. If the actual candle-power of the Welsbach lamp were 85 per cent of its rated, the illuminating power of one candle-power of incandescent light would be 1.54 times that of the Welsbach. This great superiority of the incandescent light may be partly due to the difference in color of the light rays but it is probably mostly due to the inability to accurately control operating conditions of the Welsbach mantle and to its rapid deterioration and variable initial candle-power. Mr. Wagoner then pointed out that the candle-power of the Welsbach lamp depends upon many more variable conditions than that of the incandescent lamp. The Welsbach candle-power depends upon (1) the pressure of the gas, (2) the amount of gas admitted, (3) the age of the mantle, (4) the quality of the gas, (5) the ventilation of the lamp, (6) the cleanliness of a large globe, (7) the character of glass in the globe, and (8) the physical condition of the mantle. The candle-power of the incandescent lamp depends upon only three variable factors, namely, (1) the amount of current, (2) the age of the filament, and (3) the cleanliness of a small globe.

Mr. Wagoner passed from the comparison of incandescent and Welsbach lamps to a consideration of the various methods of regulating series incandescent-lamp circuits. The shunt-box system of control, he said, is expensive and inefficient, as there is a constant core loss of about seven watts in each shunt-box. The bank-board method of control has a low first cost, but is not automatic and not flexible beyond a range of about six lamps; furthermore, a system using this method of control has a very low efficiency. Figures taken from a plant operating 50 bank boards indicated that an average of three lamps per board were constantly burning. The system which Mr. Wagoner characterized as being best fitted for controlling series incandescent circuits is one which uses an automatic reactive coil consisting of a winding divided into two sections, one movable and the other stationary, and both surrounding a laminated iron core. The movable coil is counterbalanced by weights and shifts its position automatically with changes in the current flow to a position in which the reactive effect is sufficiently greater or less, as the case may be, to bring the current back to its normal value. A modification of this system was also described in which the winding is divided into two parts, one serving to boost the e.m.f. and the other to keep the current flow constant. A coil giving 100 per cent regulation on a 3000-volt 60-cycle circuit carrying 3½ amperes has only 131 watts copper loss and no core loss when the circuit is fully loaded. When all the lamps on the circuit are cut out the total loss would be 131 watts in the winding and 130 watts in the core. The power factor at full load is 98½ per cent.

Mr. Wagoner pointed out that the use of series incandescent lamps was quite extensive in the eastern part of the United States, and gave as usual rates of charge $15 to $20, with an average of $16, per lamp per year for 25-c.-p. lamps burning on moonlight schedule or until 1 o'clock; and from $20 to $30 per lamp per year, the average being $24, for lamps burning all night and every night.

Prof. D. C. Jackson, chairman of the Committee on Correspondence Schools, then presented a report on the "Trade Education of Central Station Employees," which was generally favorable to the correspondence method of increasing the knowledge of central station employees and which contained a suggestion for a central station course of instruction. The report was unanimously adopted and a motion was carried to request the four large correspondence schools to reorganize their courses for central station employees to conform as nearly as possible with the requirements set forth in the report.

After some further discussion of the question of educating central station employees, Mr. Thayer offered an amendment to the constitution to be acted upon at the next meeting. The amendment provides that the programme of the association be altered so as to bring the reading of papers first in order and all other business to be discussed after the papers have been read at each session, with the exception of the afternoon session of the second day in which the report of the Nominating Committee comes first. The convention then adjourned to meet the following morning, at which time, there being no business to transact, the convention adjourned *sine die*. At the election of officers, which was held during the convention, Mr. E. L. Debell, of Sheboygan, Wis., was elected president to succeed Mr. Norcross, and Mr. Thos. R. Mercein was continued as secretary and treasurer of the Association.

On Thursday evening the annual banquet was held at the Hotel Pfister, at which about 100 members and visitors gathered. Secretary Mercein was the toastmaster, and responses to the toasts were felicitously given by General Charles King, Captain George Chase, Prof. D. C. Jackson and Messrs. Almert, Burch, Collins, Cutter, Donohoe, Grier, Lovett, Low, Massey, Munson, McMaster, Pinckard, Searing, Underwood, Whyte and Wolff. The feature of the banquet, however, was the presentation to Mr. Mercein of a very handsome watch by members of the association; Mr. Underwood made the presentation speech.

IMMERSED RHEOSTATS vs. WATER RHEOSTATS.

BY B. PARKS RUCKER.

Though the water rheostat is one of the oldest and most common of all apparatus for the consumption of electrical energy, it is at the same time one of the most troublesome and unreliable. The usual form consists of two metal plates immersed in a barrel of water, and so arranged that the distance between them can be easily regulated. To the water is added common salt, sal ammoniac, or some other substance which will increase the conductivity, but unfortunately at the same time the electrolytic action. The current flowing, assuming the e.m.f. and the distance between the plates to be constant, is dependent upon the conductivity of the electrolyte, and as it is impossible to keep this constant, the rheostat will take a very variable amount of current, and hence is very troublesome when a constant flow is desired.

The accompanying curves show just how this current changes with three of the most common substances used in the water—salt, sal ammoniac and washing soda. Each of these substances was tested under exactly the same conditions. The vessel was of wood, and at the start of each experiment held about 1 gal. of water at 45° Fahr., the electrodes were of sheet iron, 3 ins. by 4 ins. in size, and 3/16 in. thick, and were held in a vertical position just 3½ ins. apart. The only variable factor introduced was the amount of the substance added, just enough being used to give a good starting current. The plates were entirely covered by water and an e.m.f. of 110 volts maintained between them. The curves show how very variable the current is in a rheostat of this style, even under favorable conditions. Should more current be sent through it the boiling and bubbling would be greatly increased, and the bubbling and foaming would make the current rise and fall continuously.

It will be seen also from the curves that the current rises rapidly till a maximum is reached, and then suddenly falls off. This is the boiling point of the solution. The current afterward falls off more slowly and finally reaches a somewhat steady value. The cause of this is easily explained. Cold water has a much higher resistance than hot, so that as the water warms up its resistance decreases; moreover, the substance added becomes much more thoroughly dissolved and distributed, and at the same time the electrolytic action on the plates decreases the resistance of the electrolyte. Finally, the substance added is driven off by the heat and the current falls off, but it still stays pretty high on account of the better conductivity of the now heated water and the results of electrolysis.

When too much current is sent through the solution it boils spasmodically and foams throughout its body and the current becomes too unsteady for any use; sometimes the water boils out of the top of the barrel as fast as it can be put in.

Furthermore, the adding of the salt or other substance and water must be done very carefully; otherwise the cold water will add too much resistance and lower the current or else too much salt will send the current above the safe limit. The practicable continuous capacity of such a rheostat is limited to about 100 amperes at 110 volts for a 40-gal. barrel, or about 15 electrical horse-power, so that in a test of a large plant, where artificial load is used, many more such barrels would be needed than would be practicable.

A series of tests carried out in the electrical laboratory of the Drexel Institute on the carrying capacity of iron wires under water convinced the writer that a most satisfactory rheostat for the purpose could be made on that plan. Wires immersed in water can carry a surprising amount of current without burning off, and, if proper precautions are taken, without much loss from electrolysis. On one test a No. 14 (B. & S.) galvanized iron wire about 15 ft. long was coiled in an open spiral and immersed in about 10 gals. of water; it carried 200 amperes at 110 volts for some time, although the water did boil pretty hard. Another wire 15 mils in diameter carried 50 amperes for several minutes before burning off. Investigation showed that the wire burned off only after a thin film of vapor formed around it, thus preventing the water from coming in contact with it and carrying away its heat by convection.

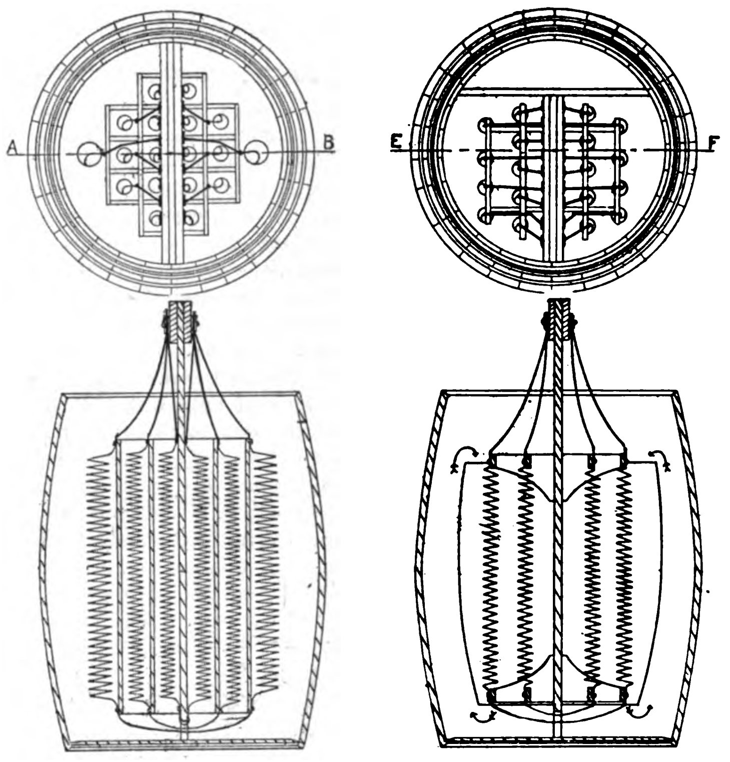
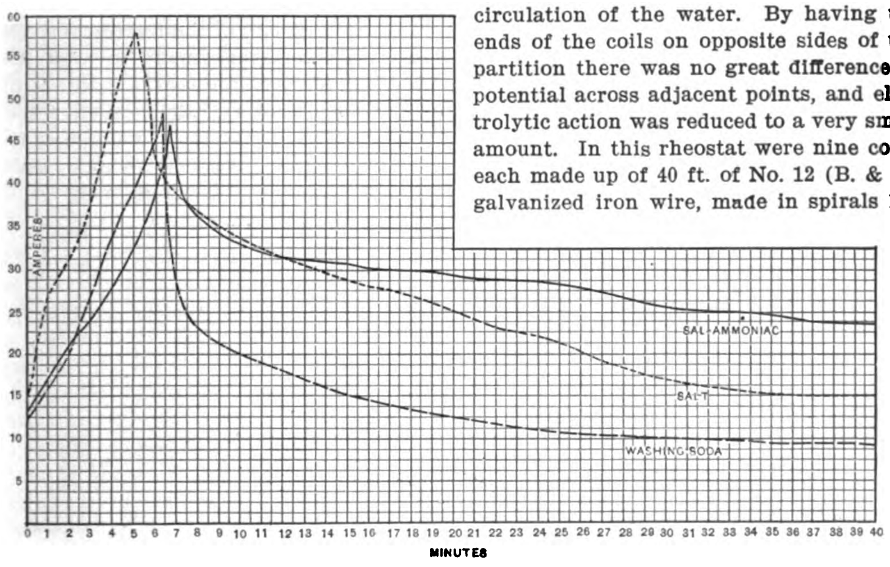


FIG. 2—IMMERSED RHEOSTATS.—FIG. 3.



CURVES FROM COMMON WATER RHEOSTATS.

The rheostat shown in Fig. 2 was designed and built according to results of some of the tests mentioned. A barrel of about 40 gals. capacity was divided vertically into three compartments; two of these compartments held the coils of wire and the third one was simply to help the circulation of the water. By having the ends of the coils on opposite sides of the partition there was no great difference of potential across adjacent points, and electrolytic action was reduced to a very small amount. In this rheostat were nine coils, each made up of 40 ft. of No. 12 (B. & S.) galvanized iron wire, made in spirals 1¼ ins. in diameter and drawn out to about 5 ft. in length. The resistance of each coil when cold was 0.55. ohm, and when carrying 145 amperes under water 0.737 ohm. Each of the coils had its own copper leads, and no part of the iron wire carrying current was under less than 3 ins. of water.

Double-pole switches were used in cutting out the coils, as it would promote electrolysis to have all the coils attached to a common connector at one end. When the water becomes heated it starts up a circulation, as shown by the arrows, and a stream of water can be kept playing into the empty compartment with good effect. Small strips of wood run through each coil and are fastened at the ends to catch the coil and prevent it from falling across others should it burn off. This rheostat was used in a 10-hour test of a power plant. Only five coils were used, each taking 145 amperes at 107 volts, or 77.575 watts in all. An intermittent stream of water, about ⅝ in. in diameter, from a tank about 15 ft. overhead, was allowed to run in the barrel, and at no time did the water reach the boiling-point. The other four coils were held in reserve, but were not needed. The writer has not the least doubt that all nine coils could have been used at once without causing excessive boiling of the water, which would have meant passing about 1300 amperes at 107 volts, or about 186 electrical horse-power.

In a later nine-hour test of a dynamo the same rheostat carried a load of 725 amperes at 115 volts for eight hours and 870 amperes for one hour without the least trouble or mishap, and gave an absolutely steady load. When the wire was put in the barrel it was 80 mils. in diameter; after the second test its smallest diameter was found to be 73 mils—a loss of 7 mils in 19 hours' run. This loss was undoubtedly due to cross currents between the wires in use and those which were held in reserve, as the smallest points in the wire were always found to be near the ends, while the middle portions were comparatively unharmed.

A 230-volt dynamo was also tested and a rheostat of the same kind with slight modifications was used. In this a barrel of the same size was divided into two main compartments, as in Fig. 3, and these were each subdivided into eight smaller compartments about 3 ins. square, plan measurement, allowing considerable open space around the coils for the water to circulate. Each coil was thus kept to itself, and cross currents were almost entirely prevented. There were seven coils, each of 75 ft. of No. 14 (B. & S.) galvanized iron wire, one coil of No. 18 wire, each one in its own compartment, and one coil of 80 ft. of No. 12 wire in the open space. As in the first barrel, each coil had its own leads, and in this barrel the leads (No. 8 copper, Underwriters' insulation), went down about 3 ins. below the top of the compartments, thus giving a long path for the stray currents to traverse to reach the next coil. This arrangement was found to work admirably, and after the test the wires were in practically as good condition as before. This barrel carried at times at least 800 amperes at 230 volts, or almost 247 electrical horse-power. Both of these barrels were kept cool with a single ¾-in. stream of water, and at no time did the water boil violently. The water was supplied at a temperature of about 50° Fahr.

Both rheostats proved perfectly satisfactory in every respect except in close regulation, and this could have been secured had wires of different sizes and lengths been used. The rheostat for 110 volts could only be changed in steps of 145 amperes without putting some of the coils in series, which would be impracticable with this construction. In the other form, however, wires can be put in series without the slightest fear of electrolysis or any other serious results, and thus the load can be graded to suit the conditions. The load itself in every case was as steady as a bank of lamps, and in this respect, at least, the rheostat was a great improvement over the old plate and solution form.

TABLE OF SAFE CAPACITIES FOR IRON WIRE IN ORDINARY AND IMMERSED RHEOSTATS.

Size, B. & S.	Circ. mils, d².	Safe cap. in air 0.014 d².	Length for safe cap. in air, 110 volts.	Safe cap. in water, 0.2 d².	Length for safe cap. in water, 110 volts.	Feet per lb. of wire.
20	1018	2.5	594 ft.	36	25 ft.	369.
19	1253	2.9	626 "	42	27 "	293.2
18	1624	3.5	673 "	50	29 "	232.5
17	2048	4.2	710 "	60	30 "	184.2
16	2583	5.0	750 "	71	32 "	146.0
15	3257	6.0	790 "	88	34 "	107.5
14	4107	7.1	840 "	103	36 "	91.9
13	5178	8.5	886 "	122	38 "	72.2
12	6530	10.1	941 "	145	40 "	57.8
11	8234	12.0	990 "	173	42 "	45.8
10	10,380	14.3	1054 "	205	45 "	36.4
9	13,090	17.1	1103 "	245	47 "	33.3
8	16,510	20.3	1354 "	293	58 "	26.0

It is obvious that a rheostat of the type described could be easily adapted for use with polyphase currents by joining the coils in star fashion at the bottom of the barrel. Where a load must be regulated to within a very small amount it is recommended that a plate rheostat be used in between the steps of the main one. Then by careful manipulation and a small load on the plate rheostat the load should be kept very constant indeed.

If the barrels are mounted on wooden bases or blocks about a foot high, any reasonable amount of water can be allowed to circulate through the barrel without danger of seriously grounding the circuit. A column of pure water 1 sq. in. in section and 12 ins. long has a resistance of over 14,000 ohms. The more water is used, the longer the rheostat will last, as the water washes away any metallic particles or other substances set free by electrolysis and keeps the coils cool.

The accompanying table gives the sizes and length of wire which it is practicable to use on 110-volt circuits for ordinary and immersed rheostats. Combination for any voltage can be made, but for immersed rheostats to be used at 500 volts, say, it would be best to put two or more barrels in series. These tables are the results of some tests made on iron wire in the laboratories of the Drexel Institute.

Abstracts from Foreign Contemporaries

Alternating-Current Ammeter and Voltmeter.—Among other instruments described by M. Aliamet in a recent issue of the "Bulletin de la Societe Internationale des Electriciens" is an interesting form of ammeter and voltmeter for measuring alternating currents, the principle of which is shown in Fig. 1. Between the poles of opposite horseshoe electromagnets, F and F', is hung a coil, C, on the vertical arm of an aluminum double bell crank lever pivoted at D. The magnet coils, B and B', are connected in series with each other, and the movable coil, C, which is of fine wire, is connected in shunt to the magnet coils. The connections are such that the movable coil is attracted by the right-hand magnet and repelled by the left-hand one. As shown in the plan view, the air gap between the poles of each magnet is very much smaller than the distance across from the poles of one magnet to those of the other, so that the field through which the coil moves is very uniform. The magnet coils are laminated, of course, and are worked at very low magnetic density, so that the field is proportional to the current flowing in the magnet coils. The movement of the mechanism is damped by means of two air dash-pots, shown in the upper part of the engraving. The travel of the arm, O, is comparatively small, and is amplified by means of the linkages between the end of that arm and the indicating needle, A. A light spiral spring, S, is provided for the purpose of bringing the needle to the zero point and annuling the effect of lost motion in the linkages. The block, P, to which the stationary end of the spring is attached, is adjustable in order to enable one to bring the pointer to the zero of the scale. The ammeters are always used in connection with a small transformer, of which the primary coil, connected in series with the work circuit, consists of a single turn of wire. The secondary winding of the transformer is always given a comparatively large ohmic resistance, in order to minimize the effect of reactance. The instrument is also manufactured as a voltmeter, in which form the coils on the electromagnets are of fine wire and connected in series with the movable coil. The magnet coils of the voltmeters, however, are wound with German-silver wire in order that the resistance of the coil may be much greater than its reactance, so that resistance will be the principal component of the impedance. The instrument is said to be fairly accurate for widely differing frequencies, a voltmeter for 110-volt circuits giving a variation of not over 2½ volts between frequencies of 25 and 80 cycles per second. The voltmeter may be rendered, however, independent of the frequency by using a small transformer, the primary of which has a very great resistance compared with its reactance and is connected in shunt to the magnet coils of the instrument, the secondary being connected to the terminals of the movable coil of the instrument. The result of this arrangement is that the e.m.f. delivered to the movable coil is increased somewhat with the frequency, thus compensating for the lower voltage at the terminals of the instrument which results from an increase in the frequency.

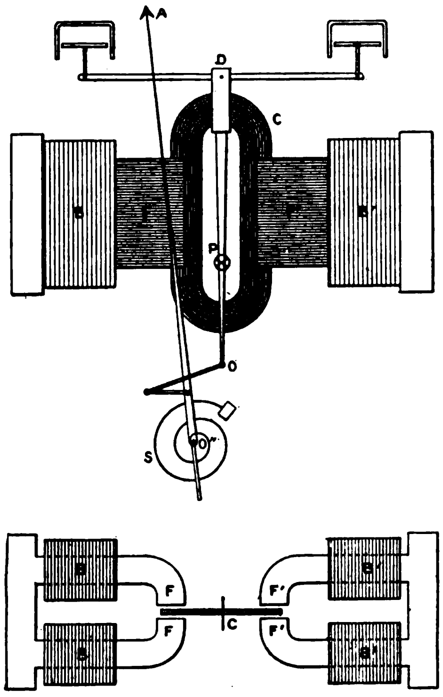


FIG. 1.—ALTERNATING-CURRENT AMMETER OR VOLTMETER.

Simple Modification of a Wehnelt Interrupter.—J. von Pallich, in a recent issue of the "Elektrotechnische Zeitschrift," gives the following simple modification of a Wehnelt interrupter in which the lead plate is replaced by a copper wire, and the platinum anode by a steel wire. A negative electrode of bright copper wire, 0.11 to 0.19 in. in diameter, is passed through a glass tube and permitted to protrude 0.07 to 0.11 in. at the bottom. A positive electrode of steel wire, 0.03 to 0.07 in. in diameter is also passed through a tube the lower aperture of which fits snugly about the wire. At its upper end the steel wire is passed through a cork reamed out to contain mercury, which forms the contact. Both tubes are then passed parallel to each other through a rubber stopper, provided with a hole at the side to permit the acid to flow back in case it should in any way get above the stopper, and placed in a flask of dilute sulphuric acid. When in operation the steel wire should be lowered from time to time as it is slowly consumed, and it will doubtless be found necessary to place the entire apparatus in a cooling tank.

A 350-h.p. Two-Cycle Gas Engine.—A recent issue of the London "Engineer" contains a description of an extremely interesting Koerting two-cycle gas engine of 350 brake horse-power. Fig. 2 herewith is a semi-sectional plan view of the engine, and Fig. 3 is a sort of diagrammatical illustration of the functions of the various parts. It is a double-acting, single-cylinder machine, the piston rod, stuffing box and the piston itself being effectively water-jacketed. The exhaust port of the cylinder consists of a series of slots around the wall, midway of the cylinder, which are uncovered by the piston just before the end of each stroke, as indicated in the upper part of Fig. 3. The admission valves are of the usual poppet type, operated by the air pressure. The air and gas are supplied to the valve chambers by separate pumps, the pump, M, forcing the gas in, and the pump, N, forcing the air. The pumps are double acting and driven by a single piston rod, as shown in Fig. 2, from a wrist pin on an auxiliary crank disc set on the main shaft so that the pin is 110° in advance of the main crank. The pumps are provided with piston valves which are operated by an eccentric on the main crank shaft, and serve to direct the gas and air first to one end and then to the other end of the cylinder, performing the same function that is fulfilled by the admission valve of a steam engine, the inlet valves on the ends of the cylinder being merely check valves to prevent back pressure from the cylinder into the pumps. The air and gas are thus kept separate until they enter the valve chamber on the end of the cylinder. The valves of the two pumps are so set that air is delivered to the valve chamber on the cylinder before gas is admitted, the object of this being to flush out the products of combustion in the cylinder before admitting a charge of gas.

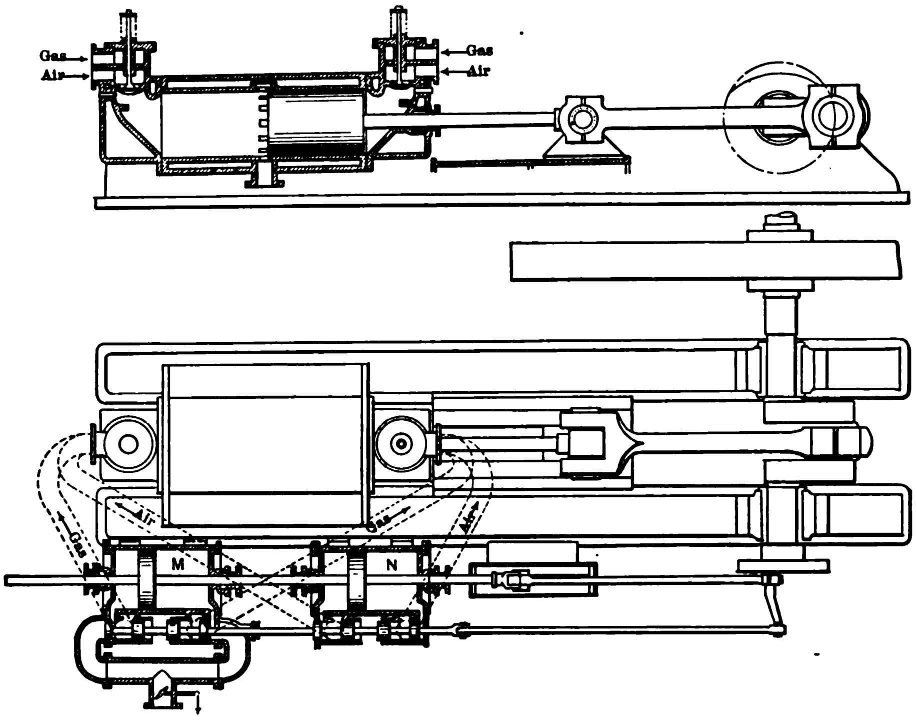


FIG. 3.—DIAGRAMMATIC ILLUSTRATION OF TWO-CYCLE ENGINE.

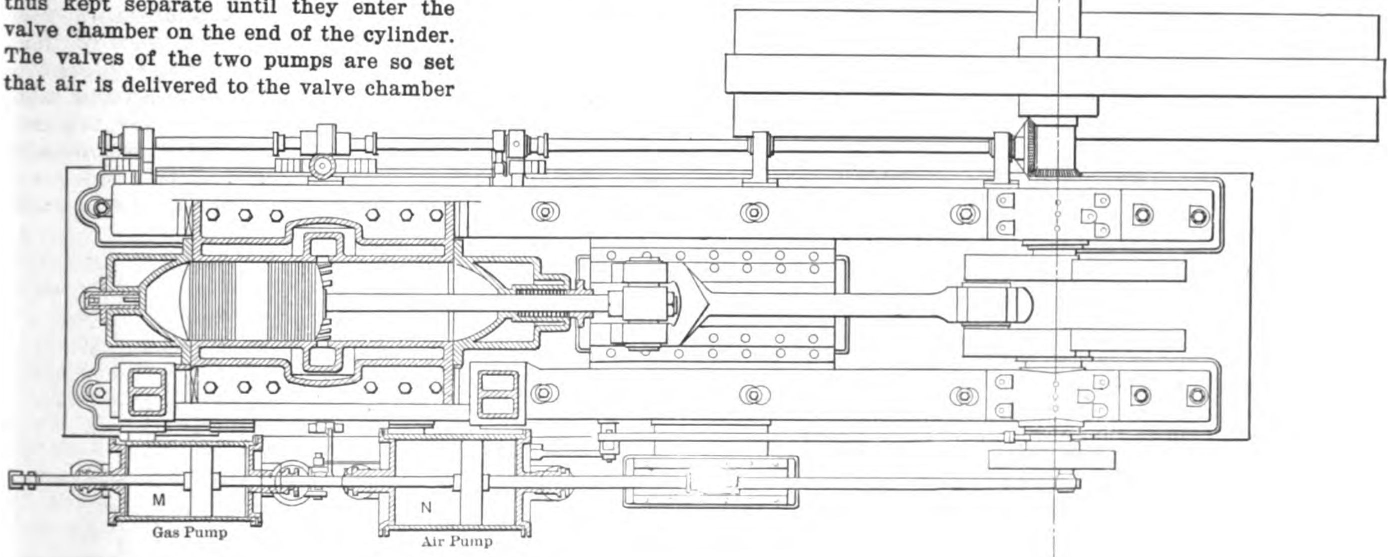


FIG. 2.—SEMI-SECTIONAL PLAN OF 350-H.P. TWO-CYCLE GAS ENGINE.

The working cycle is as follows: At the end of a working or explosion stroke the piston uncovers the exhaust port, allowing the products of combustion to discharge. When the pressure within the cylinder almost reaches the atmospheric pressure, the inlet or check valve at the end of the cylinder is forced open by the pressure of air delivered to the valve chamber by the air pump, and the fresh air forces out the remaining products of combustion. Just as the piston covers the exhaust port on its return stroke the gas valve is opened and the gas pump forces a charge into the valve chamber, where it mixes with the air which is being delivered by the air pump and passes into the cylinder. Compression then takes place during the return stroke of the piston (which is forced through this stroke by an explosion of the previous charge on the other side of it) until the crank reaches its dead center, when the compressed charge, the entrance of which has just been described, is fired. The cycle is the same on each side of the piston, of course. Regulation is effected by varying the amount of gas admitted to the valve chamber. The engine illustrated by Fig. 2 is capable of delivering 350 horse-power from its pulley. The engine cylinder is 21.6 ins. in diameter x 37.7 ins. stroke; the air pump is 24.4 ins. bore, the gas pump 19.6 ins. bore, and both pumps 27.5 ins. stroke. In a test of this engine with producer gas having a calorific value of 129 B. T. U. per cubic foot the engine developed in the working cylinder 544 horse-power. The amount required to drive the pump was 63 horse-power, leaving 481 horse-power for useful work and overcoming the mechanical friction of the moving parts. The friction load was 29 per cent, so that the mechanical efficiency of the engine was 71 per cent, leaving 341.5 horse-power available for useful work. The gas consumed per indicated horse-power in the work cylinder was 58 cubic feet per hour and the gas per brake horse-power was 81.5 cubic feet per hour. The thermal efficiency of the engine considering the indicated horse-power was 37.9 per cent, and the efficiency considering the brake horse-power was 23.8 per cent. The average speed of the engine was 101 r.p.m. At full load the compression pressure, according to the indicator diagram, was 169 lbs., and the explosion pressure 389½ lbs.

A New Form of Calorimeter.—In a paper recently read before the British Association, Prof. John Goodman described a new form of calorimeter which he had designed, and which is illustrated by Fig. 4. The author stated that the wire-drawing calorimeter had recently been discredited by reason of experiments made by Mr. Grindley, of Manchester, which showed that the specific heat of superheated steam, upon which the accuracy of the throttling calorimeter hinges, instead of being 0.48, varies from 0.4 to 0.68. In the new form of instrument Prof. Goodman does not use the wire-drawing principle. The instrument is a condensing calorimeter, consisting of a scale beam, S, from one end of which are hung two scale pans and from the other end two cylindrical tanks, A and B, each 16 ins. in diameter and 24 ins. deep. A small mixing injector, C, is attached to the bottom of the tank, A, and the cold water from this tank passes through the injector and is mixed with the steam, which is supplied by a detachable flexible steam hose attached at the connection, D, which is thoroughly sheathed for convenience in handling and also to prevent radiation. In the pipe through which the condensed steam and condensing water pass to the lower tank is inserted the bulb of a thermometer, H. An outlet cock, E, is provided for the purpose of draining the lower tank. The object in using two scale pans is to keep the steam weights separate from those which counterbalance the condensing water. The tank, A, is filled with water from the pipe, F, until it just balances the weights in the lower scale pan, which are usually two 56-lb. weights. The temperature of the water in A is tnen taken, and the steam pipe, D, after being thoroughly blown through, is coupled up. The steam-supply valve and injector water cock are opened simultaneously, and an observer begins to take readings of the temperature at H at intervals of 10 to 15 seconds. The experiment is continued until the tank, A, is nearly emptied, which usually takes about five minutes; then both the steam and water valves are shut off simultaneously, the flexible steam pipe is disconnected and the incandescent lamp near the thermometer, H, removed. The whole apparatus is again balanced by placing weights on the upper scale pan, which represent the weight of steam which has been condensed. The tank, B, is then entirely drained, and the apparatus balanced up again by changing weights on the large scale pan. The weight of the water which has been mixed with the steam is then easily ascertained. The formula for the calorimeter is as follows:

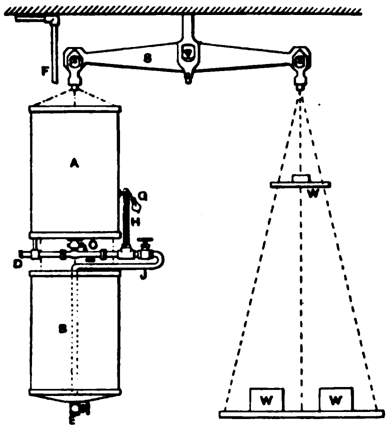


FIG. 4.—STEAM CALORIMETER.

$$Q = \frac{\frac{W}{w}(t_2 - t_1) + t_2 - t}{L}$$

in which "Q" is the quality of the steam; "w," the weight of steam taken into the calorimeter; "L," the latent heat of the steam; "t," its temperature when admitted; "t_1," the temperature of the water in the tank, A; "t_2," the mean temperature shown by the thermometer, H, and "W," the weight of the water used to condense the steam. The chief source of error in the use of the instrument lies in obtaining a reliable sample of steam.

Group-Driven Lathes with Electro-Magnetic Couplings.—To a recent issue of the "Zeitschrift fuer Elektrotechnik" J. Loewy contributes an article showing a compact arrangement of four small automatic turning lathes, provided with quick and convenient means for stopping or starting each lathe individually without the use of complicated switching devices. Four lathes are mounted on a table, as shown in Figs. 5, 6 and 7. Upon a shelf, B, a shaft is mounted which is driven by a belt from a countershaft, not shown. The shaft is equipped with four electromagnetic clutches, K; a sectional view of one of these is shown by Fig. 7. The electromagnet, E, is keyed to the shaft. The magnet is of the "double-crown" type with a single exciting coil, and has 24 poles marked N and S. The cast-iron core, E, carries a vulcanite ring, I, to which are attached two contact rings, R and R, to which are led the coil terminals and on which bear two brushes connected with the source of current. The other part of the coupling is a hollow cone pulley, the steps of which correspond with those of the lathe pulley; this cone pulley is seated on a bushing which is free to rotate and also to move in an axial direction on the shaft. The operation of the clutch is obvious. When the coil is energized the magnet poles pull the cone pulley against the beveled poles, S, which grip it and carry it around. The total resistance of the exciting coil, inclusive of the contact resistance between the brushes and slip rings, is about 430 ohms. The normal e.m.f. employed is about 85 volts, so that each coupling requires about 0.2 amperes, or 17 watts.

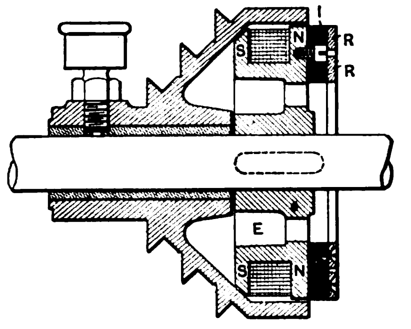
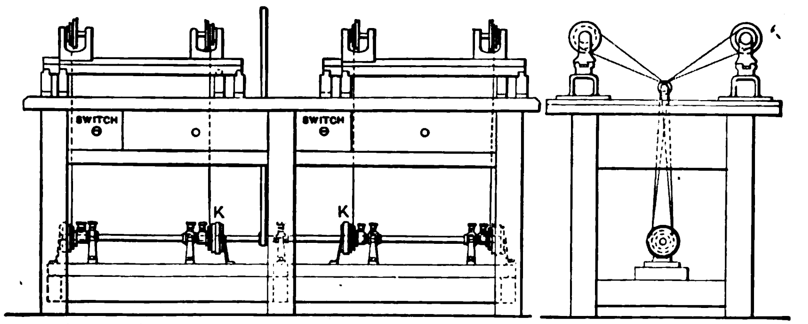


FIG. 7.—MAGNETIC CLUTCH.



FIGS. 5 AND 6.—A GROUP OF LATHES DRIVEN THROUGH MAGNETIC CLUTCHES

The Behavior of Nernst Glowers.—A recent number of the "Zeitschrift fuer Elektrochemie" contains an article by Messrs. Nernst and Wild regarding the behavior of the electrolytic filament of the Nernst lamp. The samples tested were composed essentially of the oxides of zirconium, thorium and yttrium, together with rare earths, and were in the form of thin, straight rods. A flame was employed to render them conducting at starting, and the temperature necessary for this varied from 900° to 1300° Fahr., according to the composition. The following table gives the result of six experiments with these samples, the three figures in each case representing the observations at the beginning and end of the experiments, and the mean values. The last test in the table was made with a rod supplied by the Allegemeine Elektricitäts-Gesellschaft. To obtain mean spherical candle-power, multiply the candle-power in the table by .78. The watts should be increased by 5 to 15 per cent, if it is desired to take account of the power lost in the series steadying resistance which is indispensable in the actual lamp.

Life (hrs.)	Volts.	Amperes.	Candle power.	Watts per candle.
231	184—191	0.21—0.192	28.5—24.5	1.35—1.50
	186	0.206	28.1	1.37
308	181—201	0.22—0.19	30.5—27.0	1.30—1.42
	190	0.20	29.3	1.35
447	190—208	0.41	64—57.5	1.21—1.45
	183	0.41	58.7	1.37
249	183—205	0.41—0.40	67—70	1.12—1.17
	192	0.40	65	1.20
522	184—196	0.85—1.0	123—130	1.27—1.50
	189	0.96	129	1.41
334	180—193	0.38	57.7—58	1.19—1.26
	184	0.38	58.5	1.31

Wireless Telegraphy.—It is known that for a considerable length of time Prof. Slaby has been devoting his attention to devising a means of Hertzian signaling between several independent stations so that the messages may not interfere with one another. A recent issue of the "Elektrotechnischer Anzeiger" contains an account of the recent experiments of Prof. Slaby in this direction. Upon a lecture table in Berlin were placed two sets of receiving apparatus, both of which were connected to the lightning rod on the chimney of the Schiffbauerdamm electric lighting station, the ground connection of which was not removed. Two stations, one at Schoenweide on the upper Spree, 8 miles distant, and the other in the professor's laboratory at the Charlottenburg Technical College, about 2½ miles distant, were signaled and messages received from each simultaneously. In explanation of the phenomena, the professor said that the arrangements were such that the waves in both cases were of predetermined lengths, and that the two sets of apparatus were each tuned to different wave lengths. At Charlottenburg an aerial wire 52 ft. long was attached to the roof of the college, while at Schoenweide the wire was suspended between the chimneys. In the latter case the waves had to traverse the city of Berlin from southeast to northwest, and hence were necessarily weakened by obstructions, in the shape of chimneys and tall buildings. In the experiments Prof. Slaby used a "multiplikator"—a resonator which increases the potential of the received wave and renders it easier to detect on the receiving apparatus. The invention was worked out by Prof. Slaby some time ago, and turned over to the Allgemeine Elektricitäts-Gesellschaft, which concern has developed the invention, technically, with the assistance of Count von Arco, a former assistant of Prof. Slaby.

Some Recent Electrical Patents

Storage Battery Element.—Storage battery plates of the pasted type are usually made by providing a perforated base plate or grid to which is applied the active material in paste form. In process of applying this paste it is forced into the apertures in the grid, the object being to secure the paste to the grid mechanically. When such a battery is subjected to heavy discharges the active material expands and being rigidly confined by the grid, its expansion tends to mechanical disintegration. In order to minimize this trouble the arrangement shown in Figs. 1 and 2 has been devised by Aubrey G. Eneas. This consists of a central core, *a*, of conducting material, such as lead, which may be either in the form of a rod or a tube; large washers, *b*, of porous material, through which the electrolyte may percolate; smaller spacing washers, *c*, of conducting material; and the active material, *d*, pressed into the annular spaces between the larger porous washers. The whole element is bound together by nuts at each end, and longitudinal expansion is provided for by the use of end washers, *e*, of compressible material. Fig. 1 shows the arrangement with a rod as the central core, and Fig. 2 shows it with a tube fulfilling that function. In the latter illustration the faces of the porous washers are shown grooved in order to provide additional precaution against the dislodgment of the active material between them. The claim is made that as the washers are porous the electrolyte has access to all sides of the active material except the inner face next to the small washers of conducting material which serve as electrical conductors from the central core to the active material. Patent No. 665,195.

Connection for Carbon Brushes.—It is a matter of common knowledge that the principal difficulty in the use of carbon brushes on direct-current generators and motors lies in providing a positive electrical connection between the brush and brush-holder, which will not interfere with the feeding of the brush toward the commutator as it wears. The most common practice is to transmit the current from the brush-holder to the brush by a simple contact between the side of the brush and its holder, a flat spring being ordinarily used to improve this contact. With a view to providing a more reliable connection without resorting to a positive clamp, which has been used in some cases, A. L. Rohrer has devised the simple connection shown by Fig. 3. This consists merely of a sheet-metal clip made to fit snugly over the rear end of the brush, and provided with means for the attachment of the connecting cable. This clip is soldered to the brush, and the joint is subsequently electroplated with copper or some other high-grade material. Those familiar with the progress in the art during the past ten years will remember that the Eickemeyer brush was generically similar to this one. The structural difference, however, is that the Eickemeyer brush consisted of thin spring brass, to which was soldered a short carbon tip, whereas, the present brush consists of a full-size carbon block, to which a flexible, non-resilient conducting lead is soldered. Patent No. 661,669.

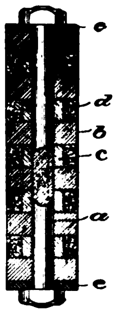


FIG. 1.

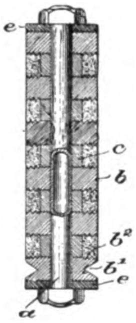


FIG. 2.

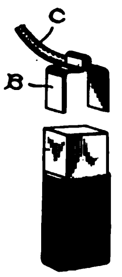


FIG. 3.

Storage Battery Meter.—It is usually desirable in the operation of storage batteries, the work of which is metered, to make a record of the energy supplied to the storage battery as well as that delivered by it. It has been the general custom to provide two separate meters for this purpose, one being switched into circuit when the storage battery is charging, and the other being substituted when the battery is discharging. A simplification of this method has been devised by Caryl D. Haskins, and is illustrated by Fig. 4. Mr. Haskins' method consists in providing two sets of recording gears on one meter and equipping the meter with an automatic polarized relay which shifts the spindle of the meter armature into and out of engagement with the two sets of gears. The relay, which is shown on top of the meter, consists of a magnet, 5, connected in series with the battery and having a polarized armature, 3, which is connected in shunt to a portion of the battery so that it is magnetized always in the same direction. It is obvious that when current is forced through the battery the relay will pull the end of the armature spindle to one side, causing the worm to mesh with the gear train on that side; and when the battery is allowed to discharge, the current flow being reversed, the end of the relay armature spindle will

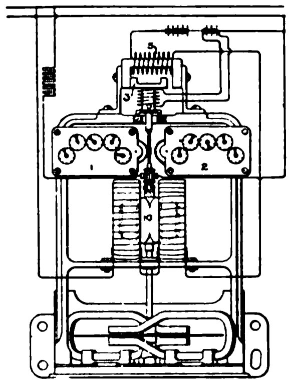


FIG. 4.—STORAGE BATTERY METER.

be thrown over to the other side, causing the worm on the spindle to engage with the other set of gears. Consequently, one set of gears records the energy delivered to the battery and the other set records the amount taken out of the battery. Patent No. 664,948.

Ceiling Rosette.—Fig. 5 illustrates a form of ceiling rosette which has been patented by John H. and Henry Trumbull. The feature of the invention consists in providing eyes, C′, in the line terminal blocks, C, through which the curved ends of the cap terminals pass when the cap is put in position and given a slight twist.

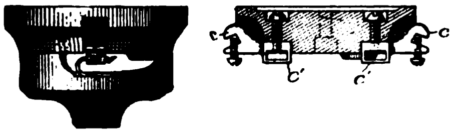


FIG. 5.—CEILING ROSETTE.

The contact pieces in the cap are arranged in the usual manner so as to allow the use of fuses, the only difference from common practice being that two of the contact pieces are provided with extensions which are curved upward, as shown in the illustration, so as to enter the eyes in the main-line terminal blocks. The extreme ends of the curved extensions are bent so as to constitute locking lugs and prevent the cap from untwisting accidentally. Patent No. 664,511.

Railway Motor.—It is well known that designers of railway motors are greatly hampered by reason of the restricted space available for the motor structure parallel with the car axles. In order to increase the axial length of the motor armature it is proposed by Edward D. Priest to do away with the ordinary form of journal box entirely, mounting the armature on a hollow sleeve and arranging this to rotate about a fixed central axle, as shown in Fig. 6. The whole interior of the hollow armature or sleeve, G, constitutes a bearing around the fixed axle, C. Liners, D and D^1, are employed in the usual manner. This construction obviously allows the motor armature to be lengthened by exactly the amount occupied by that portion of the box which projected beyond the armature winding in the ordinary type of machine. Patent No. 664,969.

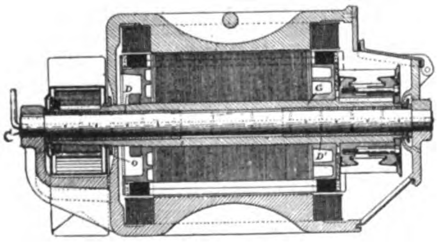


FIG. 6.—SECTION OF ARMATURE.

Arc-Lamp Carbon.—A patent has been issued to Frederick Hachmann for an arc-lamp carbon consisting of a tubular shell of hard carbon, which is filled with calcium carbide in a powdered or pulverized form, the carbide being held together by any suitable binding material, such as tar. The carbide is forced into the carbon tube under slight pressure, and is said to adhere to the walls so as to form practically a solid structure. The claim is made that in operation a certain amount of gas is generated by the calcium carbide, which materially intensifies the brilliancy of the arc formed between the ends of the electrodes. The hard-carbon shell is provided for the purpose of protecting the calcium carbide from the action of the elements. Patent No. 660,852.

NEW BOOK.

Mechanical Drawing and Elementary Machine Design. By John S. Reid and David Reid. New York: John Wiley & Sons. Cloth; 396 pages, 6 x 9 ins.; 301 illustrations. Price, $3.

The avowed mission of this book is to prepare students for advanced machine design by supplying instructions as to the application of the principles of mechanical drawing to the solution of practical problems in machine construction. The preliminary suggestions, relating to drawing instruments and materials and precautions to be observed in preparing drawings, are excellent, but if the book contains any educational matter pertaining to the art of mechanical drawing, that portion was omitted from the reviewer's copy. It does contain, however, valuable instructions as to the design of familiar machine parts and mechanical appliances, such as screws, bolts, nuts, keys, cotters, rivets, shafting and couplings, pipe couplings, journal boxes, hangers, gearing valves, etc. The final chapter on engine details is good as far as it goes, but it is peculiarly incomplete. The cross-head wrist-pin, which is about the easiest part to design excepting the piston rod, receives ample attention, while not a word is said on the subject of crank-pins, crank discs or fly-wheels! However, as intimated above, the matter that is included is excellent; the only serious fault is the failure to consider many vital subjects.

NOTES.

A New Unit of Resistance.—The "London Electrical Engineer" is guilty of the following:

"Erratum—In the answer signed 'E. M.' inserted in our last issue, the resistance of a 100 voltmeter (*sic*) is given at 30,000 watts. This should be 3,000 watts!"

Election of Officers at the Northwestern Convention. — At the recent convention of the Northwestern Electrical Association held in Milwaukee, Wis., the following officers were elected for the ensuing year: President, E. L. Debell, Sheboygan, Wis.; First Vice-President, S. B. Livermore, Winona, Minn.; Second Vice-President, W. Worth Bean, St. Joseph, Mo.; Directors, J. H. Harding, La Porte, Ind.; L. E. Kerns, Madison, Wis.; and Chas. Cuno, of Oconomowoc, Wis.

Practical College Work. — The University of Illinois has issued a manual of instructions, forms and schedules for use in electrical engineering laboratories, prepared by Profs. W. S. Aldrich and W. H. Browne. Full instructions are given, accompanied by diagrams, etc., for making all electrical measurements of a practical character and for testing apparatus, a large space being devoted to alternating currents. Several pages of the book are devoted to a list of book and periodical publications of assistance to students with respect to the subjects treated in the book. We note that many articles in the American Electrician are referred to in the latter, particularly under the heads of inspection of machinery and appliances; compounding machines; efficiency determination; alternating current induction motor and rotary converter working, and other practical subjects relating to alternating currents.

The Pupin Telephone Line Patents. — The patents of Prof. M. I. Pupin, of Columbia College, on improvements to telephone lines have been purchased by the American Bell Telephone Company. According to newspaper accounts, the consideration was a payment variously given at from $200,000 to $500,000 and an annual royalty during the life of the patents also variously stated at from $7,500 to $15,000 per year. These patents, which were issued June 19, 1900, relate to the use of inductances on telephone lines whereby the distance over which telephonic communication may be had may be greatly extended and the line cost diminished. The system, if it can be practically applied to ocean cables, will also render ocean telephony possible. The principle consists in placing inductance coils at equal distances along the line, the distance between consecutive points being equal to or less than one-sixteenth of the smallest wave length which is to be transmitted. According to the inventor's calculations, in the case of a telephone line 3,000 miles long, for example, having a resistance of 4 ohms per mile, one inductance coil of 200 millihenrys would be required per mile. Such a coil using no iron would take 1600 ft. of wire of 2 ohms per mile wound into a coil of 5 ins. internal diameter and 12 ins. in length. The line wire thus corresponds in resistance to No. 9 copper, and the coil to No. 6 copper. Should the method be applied to a submarine cable 2,000 miles long it would be necessary to introduce 8 coils per mile having an aggregate inductance of 300 millihenrys and resistance of 1 ohm per mile. The specifications of the patents state that employing cores of iron or steel, coils of this inductance can be readily made which will be small enough to go within the sheathing of a submarine cable. A coil for this purpose is described having a diameter when finished of 2½ ins. and a length of 4¼ ins. Sixteen thousand of these will be required on a submarine cable 2,000 miles long. The specifications of the Pupin patent state, however, that if iron cores are used for the coils the construction must be such as to keep down the magnetization, hysteresis and eddy current losses and distortion of the currents by the variation of the magnetic permeability of the core during each cycle of magnetization, as otherwise they will work disastrously.

Chicago Electrical Association.—The officers elected by the Chicago Electrical Association for 1901 are as follows: President, R. F. Schuchart; vice-president, Harold Almert; secretary, W. J. Warder, Jr.; treasurer, H. G. Dimick; auditor, G. M. Mayer; librarian, W. B. Hale; directors, L. G. Bassett, J. R. Cravath and H. P. Clausen. The secretary's address is 242 S. Jefferson Street. The association is in a flourishing condition and starts the new century with extremely gratifying prospects.

Wireless Telegraphy in Hawaii.—According to a press dispatch, three wireless telegraph stations have been established in the Hawaiian Islands; one at Honolulu, one at Hilo, and one on the Island of Lanai. There is a cable connection between the Islands of Lanai and Maui, and the establishment of the wireless telegraph service completes means of communication between all the islands of the group except Kauai. It is said that several rigid tests have demonstrated the entire practicability of the system.

Engines Driving Paralleled Alternators.—In the abstract, which was published last month, of Mr. H. G. Reist's paper read before the recent convention of the Engine Builders' Association, the statement relating to the permissible deviation from absolutely uniform rotation, reading as follows: "Mr. Reist stated that all engines designed for this service should not have an angular deviation of more than $\frac{5}{P}$ degrees of a cycle," should have read: "Mr. Reist stated that the rotating parts of engines designed for this service should not have an angular deviation from the position they would have with absolutely uniform speed, greater than $\frac{5}{P}$ degrees of a circle," referring to the circle described by the rotating part and not to a cycle.

The South Carolina Inter-State and West Indian Exposition will be held in Charleston, S. C., opening December 1, 1901, and closing June 1, 1902. The work of constructing the buildings is now in active progress, contracting having already been made for four of the principal structures, of which there will be eleven. The Exposition Company has its agents actively at work in different parts of the country, and it is expected that the exposition will be one of the most attractive that has ever been held in the Southern States. The power plant of the Exposition has not yet been arranged for. A general estimate calls for one plant to maintain 8500 16-c.p. incandescent lamps, a second plant to furnish 600 arc lamps of 500-c.p. each, and a third plant to supply from 1500 to 3000 horse-power for operating the live exhibits of the Exposition. The general plan of installation has been arranged so that power may be provided in every building on the grounds, and wherever practicable, that every machine shall be belted up and operated, and methods of manufacture illustrated throughout the whole range of processes from the raw material to the finished product. In order to carry out this plan, electric power will be furnished to exhibitors who will provide their own motors and connect with the main at the most convenient point. A great number of the mills are now operated by direct-connected motors, and the extension of the system is growing steadily. There is said to be an enormous undeveloped field at the South ready for the influx of machinery and electrical appliances of all kinds, which an exhibit of generators, motors and general appliances would tend to open up.

A Co-Operating Circulating Library and Electrical Laboratory.—The plan which is followed by the Chicago Central Young Men's Christian Association Electrical Club in securing a circulating library of the best practical electrical books is interesting and worthy of imitation. The club started a library fund over a year ago, the first money being the proceeds of a lecture on wireless telegraphy by Mr. Arthur Vaughan Abbott. The fund was further increased by each member of the club subscribing for one year to the American Electrician, at the regular rate; a liberal discount for the entire club subscription was allowed, and this commission was turned over to the library enterprise. With the money thus raised the club has purchased every book (46 in all) listed in the American Electrician catalogue.

The club was organized in March, 1897, and is composed of about a hundred ambitious young men who are employed in electrical or allied industries. During the past three years the club has accumulated a laboratory equipment worth about $2,000, to which additions are constantly being made. Liberal donations from the Western Electric Company, the Chicago Telephone Company, the Chicago Edison Company and other local companies have enabled the club to equip its laboratory with a fine collection of Weston instruments and other testing apparatus. The work in the laboratory is in charge of Mr. W. D. Hale, electrical engineer in charge of the testing laboratory of the Western Electrical Company. Mr. Hale has prepared a course of instruction which is given with the aid of a set of bulletins, and covers practical work with the ammeter, voltmeter, wattmeter and other testing instruments used in every-day work. In addition to the two classes in the laboratory, which meet once a week, there are classes in elementary and advanced electricity in connection with the regular work of the Association College. There are over 125 students enrolled in the electrical classes, and a total of nearly 900 in the other 55 classes of the college. The electrical classes are in charge of Mr. H. R. King, and the text-books used in both classes are Houston & Kennelly's Electrical Engineering Leaflets. The work of this club is a good example of the benefits which can be obtained by ambitious young men with only a reasonable amount of enterprise and co-operation as initial working capital.

Mr. Dooley's Review of the Century.—One of the cleverest and most humorous of skits appears in "Lightning's" first issue of the new century. The celebrated character of fiction, Martin Dooley, is borrowed from Mr. Peter Finley Dunne and made to say, among other funny things:

"Great happenin's has me an' you an' th' ithers seen in these wan hundherd years, an' Great Britain has had so many geenuses that Mack is buildin' a new patent office to Wash'n'ton. * * * * In me toime, Hinnissy, Oi've seen manny wondherful invinshuns interjooced. Oi've seen th' tillyphone put into iv'ry house, be which ye c'n talk to yure naybur acrost th' sthrate whin his number's not ingaged. Th' tillyphone is raysponsible f'r th' prisint overcrowdin' iv hell, an' th' gover'mint had to find a rimidy be diggin' up all th' r-roads an' startin' an opposishun. Oi've seen th' phonygraph invinted twict be th' sage iv Menloo Par-rk, an' no fam'ly's complate without one. Whiniver a man dies he has a wax cylindher put into his corffin with a message to his ancesthors wan thousand years hince. Oi've seen th' gr-reat invintions iv Perfessors Gilbert an' Sullivan in me time fr'm Japanese mirrors to arc lamps. Phwat man don't kape a telpher line in his back gardin f'r hangin' th' close an' bringin' up th' pertaties? Secohmeters are at iv'ry corner iv th' sthrates ladlin' out self-inducshun, an' magnifyin' springs is to be bought in iv'ry sthore. Glory be, an' whin Oi call to moinde th' sthreet kyars pulled be horses which was fur-rust cousins to th' sausages in Schwartzmeister's windy, an' see before me th' electric kyars an' th' ought-to-me-billies toot-tootin' an' runnin' down folks at iv'ry corner, me heart fills with pride, Hinnissy, to know that Oi'm livin' in th' ninetyeth cintury an' assistin' to make th' gr'reat elictric age. * * * * Oi till ye phwat, Hinnissy, th' nixt cintury will be a perspirin' awr-fillin' ixistence, phwat with toobes undher th' earth shakin' th' houses an' makin' their rints to fall—an' flyin' machines knockin' down th' chimley-pots an' dhroppin' folks into th' back yards—an' submar-rines scuttlin' all th' r-river stheamers an' landin' furrin ar-rmies in th' Regent's Canal—an' messages fr'm Mars—an' coal givin' out—an' th' sun gittin' smaller—an' th' Yeller Per-ril—an' ars'nic in whisky—an' compulsory creemayshun—an' sperrits—an'——"

"Merciful hivins!" exclaimed Mr. Hennessy, who was as white as a sheet, "whin do th' new cintury begin?"

ESTABLISHED 1889.

American Electrician,

WITH WHICH IS INCORPORATED
Electrical Industries.

CECIL P. POOLE, Editor.

Published on the first of each month by the
American Electrician Company,
NEW YORK: 120 Liberty Street.
CHICAGO: Monadnock Block.
PHILADELPHIA: 929 Chestnut Street.

JAMES H. MCGRAW, President.
A. E. CLIFFORD, Vice-President.
C. E. WHITTLESEY, Treasurer.
E. E. WOOD, Secretary.

Subscription, - $1.00 Per Year.
In the United States, Canada and Mexico.
FOREIGN COUNTRIES, $2.00.

NOTICE TO ADVERTISERS.

Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

IMPORTANT NOTICE.

Intending subscribers are warned not to place subscription orders with persons who cannot show written authority to take such subscriptions and make collections therefor, as the paper will not undertake to fill orders placed with alleged agents acting without such written authority.

Subscribers requesting a change of address should invariably furnish both the old and the new address.

Vol. XIII. FEBRUARY, 1901. No. 2

The American Electrician has a larger paid subscription list than any other electrical journal in the world.

CONTENTS.

Induction Motors in a Tobacco Factory, by F. E. Bausch 61
Lifting Electro-Magnets, by E. B. Clark... 64
Method of Measuring the Vibration of a Transmitter Diaphragm, by W. L. Merrill 67
Boiler Feeding and Feed-Water Heating, by L. B. Mather 67
Relation of Characteristic Curves of Direct-Current Dynamos to Parallel Operation, by Alton D. Adams 68
Convention of the Northwestern Electrical Association 69
Immersed Rheostats vs. Water Rheostats, by B. Parks Rucker 72
Abstracts from Foreign Contemporaries.. 74
Some Recent Electrical Patents 77
New Book 78
Notes 78
Editorial 80
A Sparking Dynamo for Gas Engine Service 82
Some Handy Kinks 83
Small Telephone Switchboard Systems, by W. S. Henry 84
Sleet Cutters, by Arthur B. Weeks 85
Steam Flue Cleaners, by Jas. F. Hobart... 86
Bucking of Railway Generators, by E. C. Parham 86
Lessons in Practical Electricity 87
Letters on Practical Subjects 88
Electrical Catechism 90
Diagrams of Electrical Connections 92
Queries and Answers 93
A System of Regulation for Series Alternating-Current Arc Lamps 94
Tests of Single-Phase Motors 94
New Apparatus and Appliances 95
Legal Notes 98
Obituary 98
Personals .... Adv. 37
Trade Publications .... Adv. 37
Business News .... Adv. 38
Northwestern Convention Notes....... Adv. 39

Long Distance and Ocean Telephony.

The announcement that Prof. Pupin, of Columbia University, had received a large sum of money from the American Bell Telephone Company for his telephone line patents has resulted in considerable sensational matter being admitted to the daily press concerning the subject and scope of these patents. In fact, the great value of the patents in connection with land lines, and which undoubtedly led to their purchase by the American Bell Company, appears to be entirely lost sight of, the newspaper accounts almost exclusively dwelling upon their application to ocean telephony, of which problem they are stated to offer a final solution. A reading of Dr. Pupin's patents, however, shows that some very serious practical and commercial considerations intervene to render such a claim at the present moment unjustifiable. There appears to be no doubt, however, that the system when applied to land lines will enable telephone conversation to be carried on over such lines of any length, with an expenditure of copper relatively small as compared with that necessary for present long-distance lines—which lines, moreover, had reached their limit of length some time ago owing to the enormously increased expenditure for copper that would be required for further extensions in length. Indeed, the purchase of the Pupin patents by the American Bell Telephone Company at a large figure appears to place a stamp on the value of the principles concerned, even though they can be applied only to land telephony.

The principle of the Pupin system is relatively simple. Inductance coils are introduced into the line for the purpose of neutralizing the line capacity, which otherwise greatly distorts and attenuates telephonic currents passing over long lines. This distortion can be partially compensated for by increasing the conductance of the line, but as each addition to the length requires a corresponding increase in cross section of the line wire, a limit is finally reached beyond which further extension is commercially impossible. Long before the day of the telephone it was known that inductance acts to neutralize capacity, and the use of inductance was in early days advocated for counteracting the evil effects of capacity in submarine telegraphy. During the past twenty years or more, the application of inductance coils to telephone lines has been proposed in a number of cases. Dr. Pupin, however, appears to have been the first to attack the problem along the proper lines.

By means of an exhaustive mathematical investigation of the question he arrived at the result that the inductance inserted in a line must not only correspond in value to the capacity of that line, but must be distributed along the line at certain definite intervals. Moreover, he deduced practical formulas whereby the amount of inductance and the distance of the coils apart may be calculated for any given case. His investigation also showed the cause of previous failures in the use of inductances for ameliorating telephonic transmission, for if such inductances are not of the proper value and placed at the proper intervals, they themselves give rise to disturbing effects that still further distort and attenuate the telephonic current. The entire feasibility of the Pupin system for land lines is illustrated by data for such a line given in the specification of one of the patents. For a telephone line 3000 miles long, for example, an inductance coil of 200 millihenrys would be required at intervals of one mile, each coil containing about one-third of a mile of wire—No. 6 in size, if of copper. As the inductance would be a simple coil of wire which, after being connected on the line, would require no attention, the application of the Pupin system to land lines is evidently entirely feasible, from both the commercial and practical standpoints.

Turning now to ocean telephony, this furnished the subject of a remarkably able paper read at the Chicago National Congress of 1893 by Prof. Silvanus P. Thompson. In this paper he showed that the only effective way to annul the retarding effects of the distributed capacity of a cable is to apply inductances along the entire length of the cable, either at intervals or continuously. Unlike Prof. Pupin, Prof. Thompson appears, however, to have failed to grasp the fact that the distance between consecutive coils should be a function of the electrical wave length corresponding to the highest frequency necessary in the transmission of speech. Notwithstanding the establishment of this principle by Prof. Pupin, the question of the applicability of his system to ocean telephony is quite another one from that of its applicability to land lines. According to data given in the patents, eight coils per mile of cable would be required for a submarine cable 2000 miles long, each coil having an inductance of 200 millihenrys. The use of a plain coil similar to that employed on land lines is evidently impracticable. By employing an iron core, the size of the inductances could, of course, be greatly reduced, but Dr. Pupin in his patents states that such coils would work disastrously if they were not constructed so as to keep down the magnetization, hysteresis and Foucault losses and the distortion of the current by the variation of the magnetic permeability for each cycle of magnetization. It will thus be seen that some very difficult problems remain to be solved before the Pupin system can be considered as rendering ocean telephony possible, or applicable even to ocean telegraphy.

Heating and Pumping Feed-Water.

The heating of boiler feed-water and its delivery to the boiler in the most economical manner is a problem involving such a large number of solutions that a general discussion of it is extremely difficult. A practice that may be ideal for one station may be highly inefficient if applied to a station in which some of the operating conditions are different. Readers of Mr. Mather's excellent article on this subject, which appears in another column, should keep this in mind, remembering that the recommendations made in the article are not hard-and-fast rules, but are intended merely as a general guide.

The proposition that boiler feed pumps should be of the highest efficiency is sound in the abstract; any machine should have as high an efficiency as is practical. But there are many cases in practice where simplicity is worth more than efficiency, and where a simple boiler feed pump consuming 150 lbs. of steam per horse-power-hour, but requires no skilled attention, is far preferable to a fly-wheel pump taking 40 lbs. of steam and demanding more or less frequent adjustment and repair. Electrically-driven pumps possess both of the advantages of comparative simplicity and high economy. The pump proper is usually of the very simplest type, and the introduction of a motor should be no drawback in an electrical power house. The freedom from a tangle of small steam pipes is an advantage which can be best appreciated only by those who have to do with the pumps. Wires can be run along out-of-the-way routes, and do not interfere in the slightest with access to a pump; moreover, the pumps may be controlled from any point in the boiler room, so that they themselves may be located wherever most convenient as regards available space in contradistinction to convenience of access for regulation.

Even in a condensing plant, electrically-driven boiler-feeding pumps can usually be installed to advantage. If the plant is not large enough to justify the installation of economizers, the feed water would ordinarily be sufficiently heated by a primary heater in the engine exhaust and a secondary heater warmed by the exhaust steam from the air and circulation pumps. Incidentally, it might be found profitable in some cases to deliver the exhaust steam of the pumps to the main engine receiver after it leaves the secondary heater. This, of course, would depend upon the amount of heat taken out by the feed-water. Where compound engines are operated non-condensing, and steam boiler feed pumps are used, the exhaust steam of the pumps is usually not needed for heating feed-water; it will ordinarily be found profitable, therefore, to deliver that exhaust steam into the engine receiver instead of turning it out into the atmosphere at 30 to 50 lbs. gauge pressure.

Tesla's Latest.

The New Century has already been enriched by two Tesla "discoveries," one of which he announces as his "first gift to the New Century." Several weeks ago he announced through the newspapers that certain electrical disturbances that had come under his observation were, he felt convinced, of planetary origin, which statement was followed up a few days later with another that he had discovered a means which rendered communication with Mars or any other planet not only possible, but easily practicable. Unfortunately for the credence of his claim, he added in a letter to the New York *Sun* some details which contradict all established ideas concerning the transmission of electric radiant energy, though the proposed means of communication with another planet purports to be based upon these same ideas.

The second and more recent announcement is that as the result of continuous effort since his first experimental demonstrations of years ago, he has at last perfected a means of producing "artificial sunshine," the new light being more economical and vastly superior to present forms of artificial illumination. In a letter to the *Sun* the following details are given: "The lamps are glass tubes which may be bent in any ornamental way. I most generally use a rectangular spiral, containing about twenty or twenty-five feet of tubing making some twelve to fourteen convolutions. The total illuminating surface of a lamp is from 300 to 400 sq. ins. The ends of the spiral tube are covered with a metallic coating and provided with hooks for hanging the lamp on the terminals of the source of oscillations. The tube contains gases rarefied to a certain degree, determined in the course of long experimentation as being conducive to the best results." In this instance also Mr. Tesla has been very fortunate in departing from his custom by giving details, for the "gift to the New Century" appears to be merely the vacuum tube light, known now for almost two centuries. The description does not indicate any advance in principle over Hawksbee's work of 1709, nor any advance otherwise over the work of Geissler fifty years ago, or that of D. McFarlan Moore in recent years.

At one time the frequent announcements by Tesla of revolutionary discoveries were a real source of harm to the electrical industry through giving rise to fears in the minds of investors that the current status of the electrical industry is insecure. The lay public appears, however, to have finally become surfeited with promises followed by no fulfillment, and the more recent announcements of Tesla have been received by the newspaper press with few exceptions—mostly of the "yellow" variety—in a changed spirit. Instead of serious consideration being given to his claims, he is rapidly becoming a subject for the irreverent mirth of the newspaper paragrapher, one of whom comments as follows: "Mr. Tesla is thus on the very eve of a discovery even more remarkable than the many others on whose eve he has been so often and so long. It may be asserted confidently that if any one on earth can understand Mars it is Tesla; and conversely, that if any one can understand Tesla, it must be an inhabitant of Mars." To quote sorrowfully an English electrical contemporary: "It is pitiable to see the engineer who invented the polyphase system of power transmission and who has done such valuable original work for other departments of electrical engineering, so fond of the cheap notoriety to be gained by sensational paragraphs in daily papers."

A SPARKING DYNAMO FOR GAS-ENGINE SERVICE.

Although the majority of dynamos and motors of recent design are of the circular-yoke type, with radial poles, the Manchester type of field magnet has many points of merit, particularly in machines designed for amateur construction. The patterns are more easily made, and although there is more actual machine work to be done, it is of a character more easily performed than that on the circular-yoke type, taking into consideration the facilities possessed by most amateurs for this sort of work. An interesting little machine of this type has recently been built by Mr. B. F. M. Weaver, of Wilmington, Del., and is illustrated herewith.

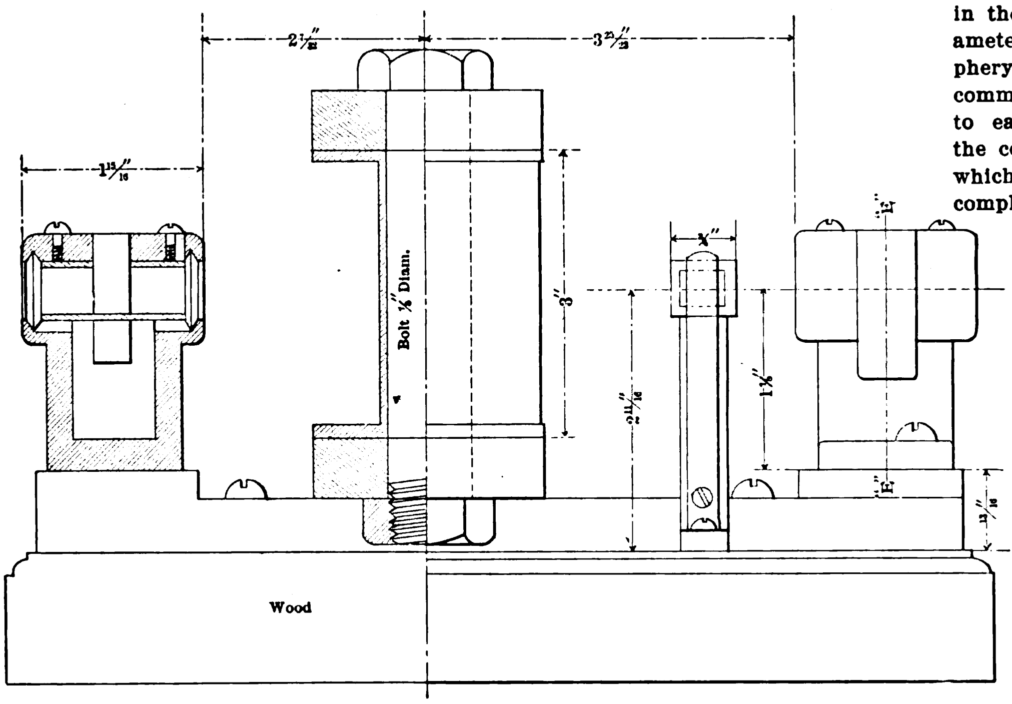


FIG. 1.—SEMI-SECTIONAL SIDE ELEVATION.

Fig. 1 is a partly sectional side elevation of the field magnet frame, base and journal pedestals; the dimensions are all indicated on the sketch. Fig. 2 is a transverse sectional view of the field-magnet pole-pieces and the wood base. The magnet pole-pieces were made of a good grade of cast-iron, and the magnet cores consist of ordinary 7/8-in. wrought-iron bolts, machined just enough to make them fit snugly in the holes of the pole-piece flanges. The distance from center to center of the magnet cores is 6 ins. There are no shoulders on the magnet cores, the pole-pieces being held apart by the magnet coil spools, which may be made of either composition metal or cast-iron. These spools are each 3 ins. long over all, and the barrel is bored out to fit the magnet core snugly. The outside of the barrel is turned down to 1 1/8 ins. diameter. The heads of the spools are 2 3/8 ins. in diameter.

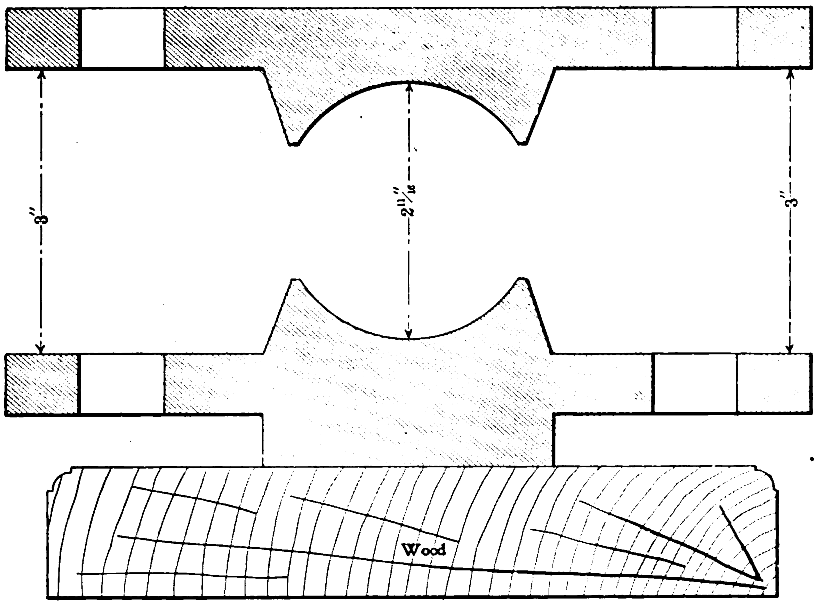


FIG. 2.—TRANSVERSE SECTION OF FIELD MAGNET YOKES AND POLE-PIECES.

Fig. 5 is a sketch of the armature, commutator, shaft, and pulley. The armature core is of the usual laminated type, made of discs 2 5/8 ins. in diameter and of the shape shown by Fig. 4. The coil holes in the armature disc are 5/16 in. in diameter and flared out toward the periphery of the disc, so as to leave a communicating slot through the edge to each hole. It will be noticed that the central hole in the armature disc, which is 5/8 in. in diameter, is not a complete circle, but is flattened on one side in order to form a feather for communicating positively the rotation of the shaft to the discs. The shaft has a corresponding flatted side, of course, so as to fit snugly in the central hole of the disc. The discs are clamped between two brass flanged collars, the flanged portion of the collars being 1 3/4 ins. in diameter and the barrel 1 in. These are screwed on the shaft as shown in Fig. 5, and one of them is provided with an additional outer flange, which serves to prevent oil from finding its way over to the armature core should any of it creep out along the shaft. The magnetic portion of the armature core

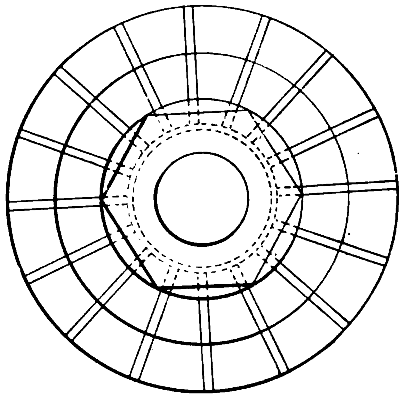


FIG. 3.—END OF COMMUTATOR.

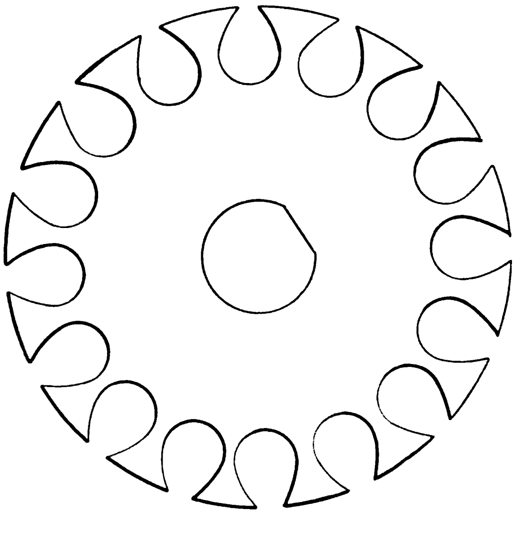


FIG. 4.—ARMATURE DISC.

is 2¼ ins. long and the length over all, including the clamping collars, is 4⅜ ins.

The pulley is of brass, cast with a solid central web instead of spokes, on account of the smallness of its diameter. It is 2½ ins. in diameter and 1½ ins. wide on the face.

The commutator is of the usual type, with the segments beveled at each end for drawing together. The segment is undercut at only one end, however, where the connecting lug extends over the rear beveled collar. The clamping collar at the front end of the commutator fits smoothly over the core, but is not threaded; it is forced into place by an auxiliary nut on the core back of it. Fig. 3 is a front view of the commutator, which is 1½ ins. in diameter at the brush tread by ¾ in. axial length, and 2 ins. in diameter over the connecting lugs, which are 5/16 in. thick axially.

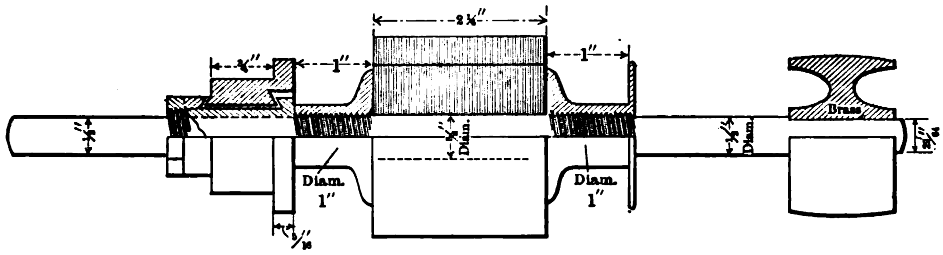


FIG. 5.—ARMATURE, SHAFT, COMMUTATOR AND PULLEY.

The brush-holders, one of which is shown in Fig. 7, are very simple in construction, consisting of a brass standard carrying at its upper end a rectangular box for the carbon brush and provided with a flat phosphor bronze or brass spring screwed to the standard near its base and bent to such a shape as to enable the upper end to press against the back end of the brush. The brushes are ½ in. wide, 7/16 in. thick and 1 in. long.

The journal pedestals are clearly snown in Fig. 1 and by Fig. 6. They are of the self-oiling pattern, having oil rings an inch in diameter outside and 13/16 in. diameter inside; they are ¼ in. wide parallel with the shaft. The oil reservoir is made with parallel sides above the center in order to facilitate the construction of the box by amateurs. The width is 1 1/16 ins. transversely and ⅞ in. axially. The boxes are provided with bushings of ½-in. bore and ⅝-in. outer diameter; they are 1½ ins. long each. These bushings are held in place by small machine screws set into the top of the journal box casting.

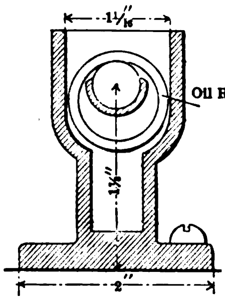


FIG 6.

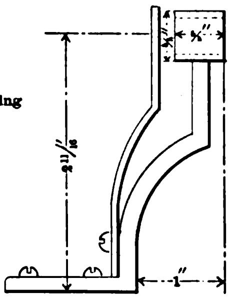


FIG. 7.

The machine has been built with two armature windings, one for 14 volts and 3 amperes, and the other for 32 volts and 1¼ amperes. The 14-volt winding consists of 16 coils of No. 20 double cotton-covered magnet wire, each coil containing 16 turns of wire. The armature winding for 32 volts consists of 16 coils of No. 22 wire, each coil containing 40 turns of wire. Each field coil contains 26 layers of No. 25 double cotton-covered wire, each layer containing 92 turns, so that there are 2392 turns of wire in each coil. The two field coils are connected in multiple when used in connection with the 14-volt armature and in series when used with the 32-volt armature, the fields being connected in shunt with the armature.

The speed of the machine for 14 volts is 2400 r.p.m.; for 32 volts it can run a trifle slower than this. Fig. 8 shows the completed machine, as built by Mr. Weaver, with a pilot lamp on the terminal board. This machine is of the simplest possible construction consistent with practical results, all of the fitting, with the exception of that on the brush-holders, consisting of plain lathe work.

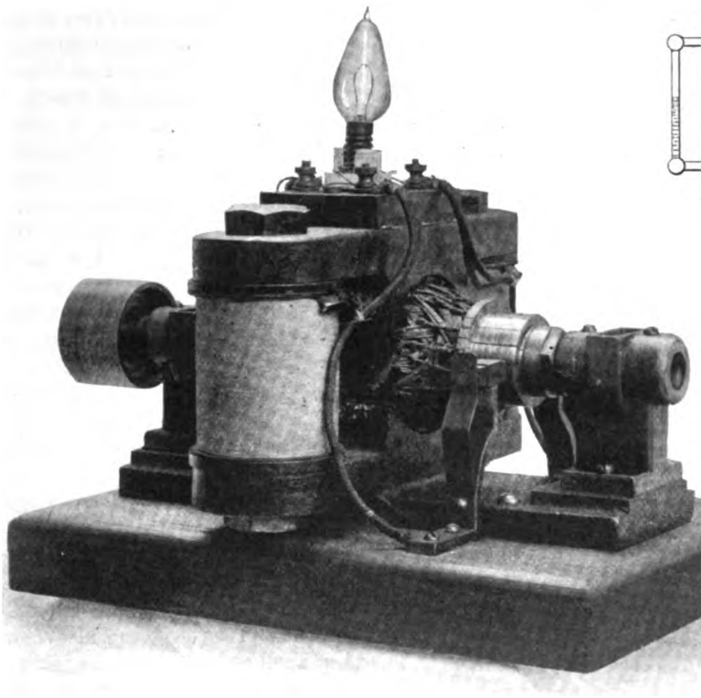
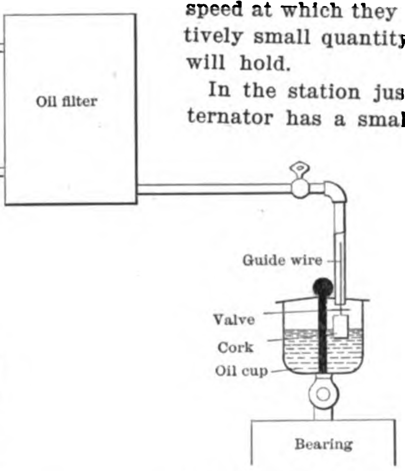


FIG. 8.—THE COMPLETE MACHINE.

SOME HANDY KINKS.

The writer recently happened in upon E. W. Kramer, chief engineer of the electric light station of the Council Bluffs (Iowa) Gas & Electric Company, and found several wrinkles that will probably be of use to others operating similar small plants. The first one noticed was so simple that it is a wonder it is not more generally used under similar circumstances; it was an automatic oil feeder for old-style bearings. Small alternators built before the days of self-oiling bearings usually require frequent re-filling of oil cups because of the high speed at which they run and the comparatively small quantity of oil that the cups will hold.

In the station just mentioned each alternator has a small oil filter on top of the machine, from which oil feeds by gravity to the oil cups. To prevent the oil from feeding too fast, a cork float is provided in the cup to open and close the inlet. This float is on a guide wire which sticks up into the oil feed pipe, as shown in the accompanying sketch. On the guide wire above the cork is a leather gasket or washer which shuts off the oil flow by closing the end of the supply tube when the oil gets above a certain height in the cup. The cork float automatically regulates the flow of oil to such an extent that the oiling does not need any attention after once being started except to keep the filter on top of the machine full and empty the drip tank underneath. Those who know how often alternator oil cups need filling and what a burden both to mind and body it is to keep them full will appreciate this scheme.



AUTOMATIC OIL FEED.

Another useful little device found in that station was an electro-hydraulic damper regulator. A shunt circuit from the field of an exciter, with a lamp in series, furnishes current for the device. A steam gauge is fitted up so that as the pressure rises to a certain point it closes a circuit through an electromagnet, which in turn opens a needle valve that admits water under pressure from the city mains to a cylinder, moving a piston in the cylinder and so closing the dampers. Regulation of pressure is very close with this device and is so cheap and simple as to be within the reach of any plant.

This station has old-style Westinghouse compensator voltmeters and contacts have been provided so that when the pointer swings more than a predetermined amount to either side of the mark indicating normal voltage a red lamp under the voltmeter lights up; hence, the attendant can see from a distance that the circuit requires regulation.

◆

SMALL TELEPHONE SWITCHBOARD SYSTEMS.

BY W. S. HENRY.

As stated in previous articles, all switchboards should be wired and constructed with complete metallic circuits; that is, with two wires for each telephone circuit and no common wire or ground return. One method of wiring a simple switchboard with two wires for each circuit is shown diagrammatically in Fig. 4. In an actual switchboard the keys would be constructed in a much more compact form than is shown here. In this diagram, D and D′ are two subscribers' annunciators,* commonly called subscribers' drops, and T and T′ are jack tip-springs that normally make contact with a wire running to their respective annunciators. When a plug is inserted in the jack the tip of the plug makes contact with the tip-spring and pushes the latter away from the annunciator contact, and the sleeve of the plug makes contact with the thimble (S or S′) of the jack, as shown at the right side of the figure where the plug, P′, is inserted in the jack. It is better to make S and S′ rubbing contact springs, like T and T′, and this is usually done now on all good switchboards; this will be shown in a later diagram.

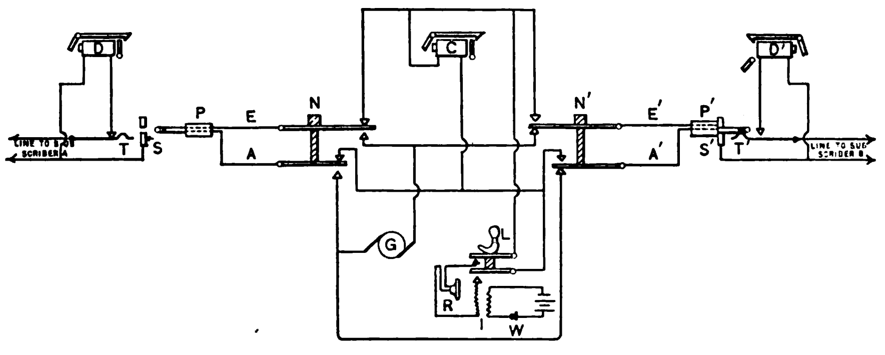


FIG. 4.—DIAGRAM OF CONNECTIONS FOR A SIMPLE SWITCHBOARD.

In Fig. 4, E and E′ are the sleeve strands, and A and A′ the tip strands of the operator's cord circuit; N and N′ are the ringing keys for ringing up subscribers over the plugs, P and P′, respectively; CO is the clearing-out drop, bridged across the tip and sleeve strands of the cord circuit; G is a magneto-generator operated by hand or by an electric motor. Depressing the ringing key, N, will evidently connect the generator, G, to the wires, A and E, and at the same time disconnect them from all other parts of the operator's circuit. Similarly depressing the other ringing key, N′, will connect the generator, G, across the wires, A′ and E′, and disconnect these latter wires from all other parts of the cord circuit. L is the operator's listening key or cam. When the handle of the cam is drawn forward the operator's talking and listening circuit is connected across the cord circuit—i. e., across the two wires running to both plugs. I is the induction coil, W the microphone transmitter, H the battery and R the watch-case receiver. D and D′ are series-wound drops and CO a bridging-wound clearing-out drop.

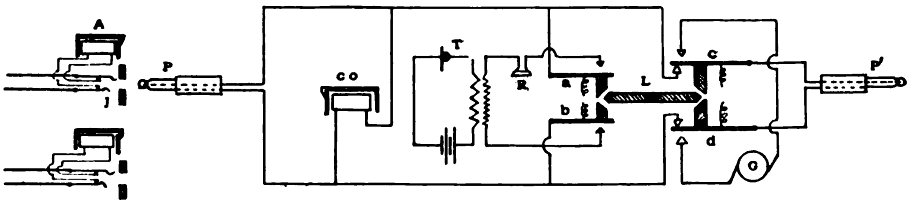


FIG. 5.—DIAGRAM OF SWITCHBOARD WITH COMBINED RINGING AND LISTENING KEY.

The operation of this switchboard is exactly the same as the one described last month. If subscriber B sends in a call, the shutter of the drop, D′, falls, the operator inserts the answering plug, P′, into B's jack, restores the drop now or later, draws forward the handle of the listening cam, asks for and receives the number of the subscriber to whom B desires to talk, inserts the calling plug, P, into that jack (suppose it is A's jack), and depresses the ringing key, N, which sends a ringing current out over the line running to subscriber A only; A having the call and the cam, L, having been restored to its normal vertical position, the two subscribers are properly connected. When the conversation is finished one or both subscribers ring off, causing the shutter of the clearing-out drop, CO, to fall. The operator then removes both plugs from the jacks, and restores the shutter of the clearing-out drop; then the circuits are in their normal position once more.

In the diagram, the ringing key, N, and the listening key, L, are shown in their normal position, and the ringing key, N′, in its depressed or ringing position. Ringing keys should always be constructed so that they will return to their normal position when released, but the listening key must usually be restored by hand.

It will be noticed that by this system of ringing keys the operator can ring out over either plug P or P′; this is convenient, although not absolutely necessary. It is convenient in case the calling subscriber leaves his telephone while waiting for his connection to be made at the switchboard; as a rule, there is really no excuse for his doing so. This provision for ringing out over both plugs requires two ringing keys, and hence twice the number of contacts for the purpose of ringing than if only one key is used and provision made for ringing out over one plug only. The latter method has some advantages; there are fewer contacts for the subscribers to talk through, and the fewer contacts there are the better, for it means fewer points at which there is liable to be trouble, and, of course, less cost in manufacture. On the other hand, where this provision for ringing out through both plugs is not made, the operator would have to reverse the plugs in the jacks in order to ring up the original calling subscriber in case the latter should have left his telephone before the operator had obtained the desired connection.

Fig. 5 is a diagram for a simple switchboard, with a combination listening and ringing key, L; P is the answering plug, and P′ the calling plug. When a subscriber's drop falls, the operator always inserts the front or answering plug, P, into the jack corresponding to the drop whose shutter fell. When the plug has been inserted the tip of the plug makes contact with one spring and the sleeve with the other spring, and the plug also spreads the two springs sufficiently to disconnect both ends of the annunciator circuit, thereby cutting the annunciator entirely out of the circuit and connecting the two line wires with the tip and sleeve strands of the cord circuit. In order to ask for and receive the number of the subscriber with whom the calling subscriber desires to be connected, the operator pulls forward the handle of the combination key, L. This spreads the two springs, *a* and *b*, thereby connecting the operator's telephone across the tip and sleeve strands of the cord circuit. The key is so constructed that it will remain in that position even if the operator lets go of it.

---

*There are, of course, no subscribers in an interior telephone system. The term "subscriber" is used merely to designate the person whose telephone is connected with the system.

After learning what subscriber is wanted, the operator inserts the rear or calling plug, P′, into the proper jack. As in the case of the answering plug, the insertion of the calling plug into the jack cuts out the annunciator of the subscriber called and connects one of the two jack springs with the tip and the other with the sleeve of the plug. The operator then pushes the handle of the key, L, away from her. After the handle passes the middle and normal position, the springs, *c* and *d*, are spread apart, thereby disconnecting the answering from the calling plug, and then connecting the two sides of the calling plug across the generator, G. Thus a ringing current is sent over the line to the second subscriber's instrument. The key, L, will stay in the ringing position only as long as the operator holds it there; the moment she releases it the key automatically returns to its center position.

The ringing current cannot flow in the calling subscriber's circuit and consequently no disagreeable sound, due to ringing up the desired subscriber, is heard in the receiver that the calling or original subscriber is holding to his ear while waiting for the subscriber called to reply. Moreover, this key system has comparatively very few contacts, the voice currents having to pass through only one pair of contacts in the cord circuit. On the other hand, if the calling subscriber leaves his telephone the operator cannot ring him up without first exchanging the positions of the answering and calling plugs. When the handle of the key, L, returns to the middle position the two spring-jacks are properly connected through the cord circuit and the two subscribers may converse. When the conversation is finished, ringing off by either one or both causes the shutter of the clearing-out drop to fall, as before described.

Many switchboards are provided with a switch whereby either a small power or hand generator, as desired, may be connected to the ringing key. Where the subscribers' drops are entirely cut out of the circuit during a conversation they need only be series-wound, and they need not be iron-clad. Iron-clad drops would be more efficient, to be sure, but since they are entirely cut out of the circuit during the conversation, they cannot cause cross talk. The clearing-out drop, however, should be a good iron-clad bridging drop.

In some cases, and at certain times in many small systems, there are not enough calls to require the constant attention of an operator, and, consequently, she may leave the board temporarily to do something else nearby. In such cases an auxiliary feature known as a night-alarm attachment is very desirable. Such an attachment will cause a bell to ring whenever the shutter of a subscriber's drop falls. This is shown in connection with the drop in Fig. 6.

When the shutter, S, falls, the spring, *t*, which is made of very thin spring metal so as to be easily bent, is pressed into engagement with the contact pin, *u*, by the heel projecting from the bottom of the shutter. The spring, *t*, and contact pin, *u*, form the terminals of a circuit containing a battery and an ordinary vibrating bell, and the bell is therefore sounded whenever a drop falls, unless the bell circuit is open at some other point by a switch, which would be the case during the busy part of the day, when enough calls are received to require the entire attention of the operator. All drops can, of course, be connected so as to require only one bell and one battery, and by means of a simple switch the alarm circuit may be readily cut in or out.

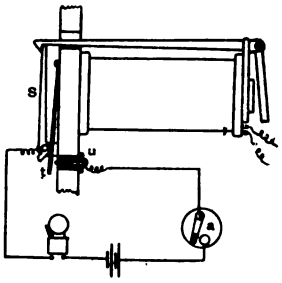


FIG. 6.—NIGHT BELL ATTACHMENT.

SLEET CUTTERS.

BY ARTHUR B. WEEKS.

Electric railway companies in many parts of the country are greatly annoyed by sleet forming on the trolley wires during portions of the winter months, some being hampered even to the point of shutting down. Cast sleet wheels are made to overcome this difficulty, and in some localities may give satisfaction; but the writer's experience with them has not been very encouraging; a wheel does not seem to solve the problem and some sort of scraper device is required to remove the sleet successfully.

A method still employed on some roads is to remove the trolley wheel and allow the fork to drag along the wire. This is satisfactory so far as it goes, and shows that a sliding contact is preferable to a revolving one for cutting off sleet. The wheel with spaced cutting edges is apparently just what is needed, but its edges soon wear smooth and severe flashing, so destructive to wheel and wire, follows. There is no flash with a properly constructed scraper.

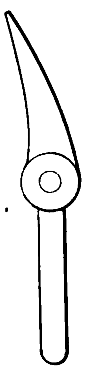


FIG. 1.

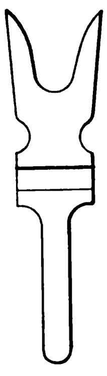


FIG. 2.

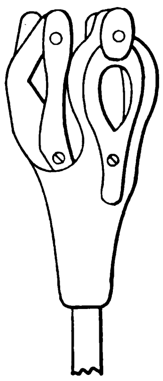


FIG. 3.

Several scraping devices have been suggested at times; but so far as the writer knows, none has yet proved successful, the chief objection being that the projecting parts invariably pull off span wires and hangers. The scraper illustrated in Figs. 1 and 2, however, has been used during the most trying weather for three seasons, and has been found entirely satisfactory on all occasions.

A glance at the cuts will show the construction, but a few suggestions in regard to its use may be advantageous. As soon as there are signs of trouble a scraper should be placed on one car on each line if the line is short; if the line is long or the sleet is very heavy, a scraper should be put on one car going each way. If night cars are not run and the wires must be cleaned before the cars start in the morning, one or more trips on each line a little earlier than usual will accomplish this. Frequently this trip can be made by the sand or salt car. A scraper should not be placed on the sweeper, if it is avoidable, as the sweeper should not be subjected to chances of delay.

To apply the scraper, remove the trolley wheel, put the scraper in its place and re-insert the trolley pin, not neglecting the cotter pins. The scraper should fit loosely on the trolley pin so as to avoid any delay in getting it into place, as nothing is more trying than replacing a wheel in rainy or sleety weather, and nothing is gained by a tight fit. As indicated by the sketch, the lower end of the scraper goes down into the trolley fork, Fig. 3, which thus holds it rigidly in place. Provision should be made for plenty of clearance when in position on the wire, and no attempt should be made to back a car with a scraper attached, or trouble will follow.

The crew should give the scraper their undivided attention while on these trips; the attendant on the rear platform should always hold the rope, and the car should not be run faster than is compatible with absolute safety. It must not be expected that the scraper will remain on the wire at cross-overs, turn-outs or curves; special care should be observed at these places.

These scrapers are made of steel, the cutting edge being drawn to a dark blue. It would seem that a scraper of this kind would cut the trolley wire, but careful tests and close observation prove that it does not harm the wire in the least. The sleet seems to offer all the protection necessary; but as the pressure upon the wire is but from 15 to 40 lbs., it could hardly do much damage, even if run on a dry wire. The scraper should be removed as soon after its work is completed as possible.

STEAM FLUE CLEANERS.

BY JAMES F. HOBART.

As stated in a previous article,* one of the principal methods of cleaning boiler tubes is to blow out the soot and other accumulations by means of steam blowers. Of these there are several types in general use throughout this country. Fig. 1 illustrates one of the best known tube blowers, which is made by the Cleveland Flue Cleaner Manufacturing Company, Cleveland, Ohio, known as the "Old Reliable." The head of this cleaner is so constructed that the jet of steam delivered by it takes a spiral course, the result being that the steam jet wipes the walls of the tube diagonally as well as longitudinally. The nozzle is cone-shaped so that it will fit closely into tubes of different sizes.

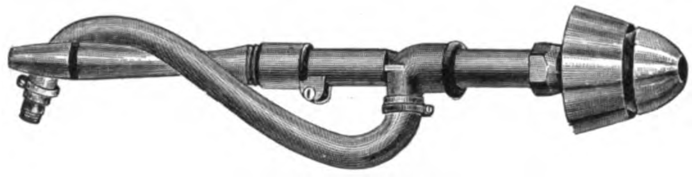


FIG. 1.—"OLD RELIABLE" CLEANER.

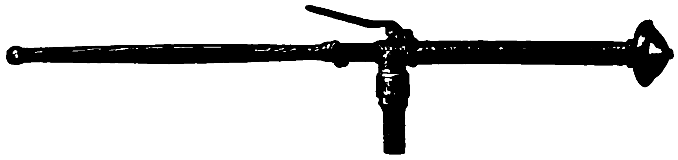


FIG. 2.—FAVORITE TUBE CLEANER.

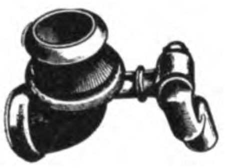


FIG. 6.—TWO-WAY CLEANER.

Fig. 2 represents the Favorite flue cleaner, made by the Haydenville Manufacturing Company, New York City. The nozzle is somewhat similar to that of the "Old Reliable" cleaner in its contour, having the form of a flattened cone, which enables it to be used with different sizes of tubes. The cleaner is provided with a stop valve located in the elbow just above the connection for the steam hose.

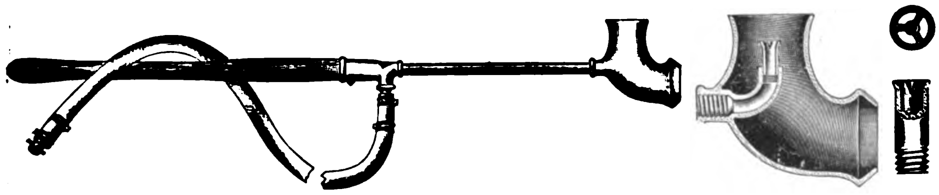


FIG. 3.—THOMPSON SOOT EJECTOR.

Fig. 3 illustrates a unique form of cleaner which operates by suction instead of by blowing. An enlarged view of the cleaner head is shown at the right of the engraving. The right-hand opening of the elbow is applied to the end of the tube and the steam jet discharging upward creates a vacuum in the tube, causing the air to rush through from the other end of the tube and sweep out the soot. An enlarged view of the steam nozzle is shown at the extreme right of the engraving, the upper figure being a plan view of the nozzle. This ejector, which is popularly known as the "soot sucker," is manufactured by Richard Thompson & Co., New York City. This firm also makes a modification of this cleaner which drives through the tube a jet of steam and a column of hot air for use when there is limited space at the uptake, and in the case of vertical tubular boilers.

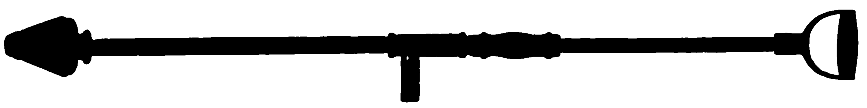


FIG. 4 —COGGESHALL TUBE CLEANER.

Fig. 4 shows a tube cleaner the operation of which is also based upon the production of a partial vacuum in the tube. The head of this tube cleaner, shown by Fig. 5, is cone-shaped, and carries four ribs or flanges, so that when the head is inserted in the end of the tube there is an air space around the shell of the cleaner head through which air can be drawn. The jet of steam delivered by the nozzle forms a partial vacuum in the tube, into which air is drawn through the annular spaces around the cleaner head at a high velocity. The current of air assists in cleaning out the soot and also drives out any moisture which would otherwise be left by the steam. This cleaner is made by the Coggeshall Manufacturing Company, New York City.

A cleaner somewhat similar in design to the Thompson "soot sucker" is manufactured by the Oliver P. Clay Company, Cleveland, Ohio, and illustrated by Fig. 6. This is known as the "Two-way" flue cleaner, being adapted for use either as a soot sucker or as a blower, according to which outlet of the cleaner head is inserted in the end of the tube. The interior arrangement is somewhat similar to that of the Thompson soot sucker.

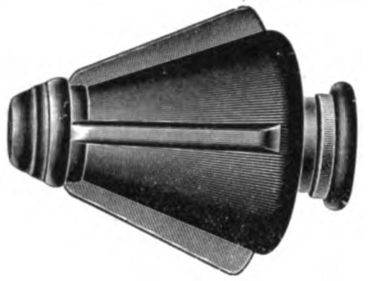


FIG. 5.—COGGESHALL CLEANER HEAD.

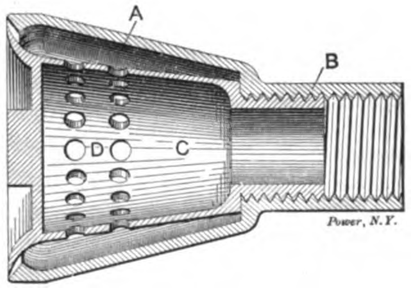


FIG 7.—SEMKE CLEANER HEAD

Fig. 7 is a sectional view of the head of a steam flue cleaner devised by Wm. Semke, Harrison, Kan. The engraving is practically self-explanatory. The steam passes from the inner chamber, C, through the holes, D, into the outer annular chamber, and thence through a restricted annular opening into the tube. The object of this arrangement is to compel the steam to sweep along the wall of the tube instead of passing through its center.

---

*Page 579, December, 1900.

◆

"BUCKING" OF RAILWAY GENERATORS.

BY E. C. PARHAM.

Dynamo tenders and others interested in the care and running of street railway generators, especially in small stations equipped with two or three generators only two of which are required in service most of the time, may have had occasion to notice that when the load is light the dynamos show an inclination to flash violently at the brushes, or as it is usually put, although the name is out of place, to "buck." This action does not take place when there is only one dynamo on the line; there must be at least two machines in parallel; nor is it as apt to take place when there are several dynamos in service, because one of the favorable conditions of the action is a light load, and it is not usual to run three or more machines to carry a very light load. The experience of most power-house men seems to indicate that dynamos do most of their "bucking" just at the time when the load is getting too light for the machines that are running. This is especially the case when two machines are running on a load that one machine can easily carry. Reference to Fig. 1 will help to show why this is so.

In the diagram A and A^1 are the armatures of two generators running in multiple on the outside load indicated by R. The fields of the two dynamos have been left out in order to simplify the diagram. As long as there are any cars running, the circuit, R, is closed and the two dynamos have a common path through which to deliver current. But when the load gets very light there will be a time now and then when the controllers on all of the cars will be at the "off" position at the same time, and the outside circuit will be open so that there will be no common path for the two dynamos to work through, or, what amounts to the same thing, there may be a ground or other fault on one of the cars so that the excessive current will blow a fuse or circuit-breaker situated at some point such as X, in the outside circuit. In either case the common path is broken and the two dynamos are left to fight it out in the local circuit, B, C, F, E. If the two machines have been thrown together properly so that both generate the same e.m.f. on open circuit, no trouble will follow when the line circuit is opened, because the two e.m.fs. being equal and opposed, no current can flow in the local circuit; but if at the time the line current is open the field strength of one machine is such that its armature can generate an open circuit 10 or 20 volts more than the other machine generates, the dynamo with the higher voltage sends a current backward through the armature of the lower voltage armature and runs it as a motor.

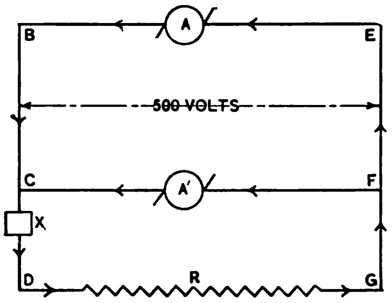


FIG. 1.—TWO GENERATOR ARMATURES IN PARALLEL.

If the machines are highly compounded the series field of the motored machine may be strong enough, if the difference in voltage between the two is great, to try to reverse the direction of rotation of its armature (since series dynamos run in the opposite direction as motors) in which case there will be a short-circuit which gets worse as the magnetizing effect ot the series windings on both machines gets stronger. If the two machines are shunt machines, the demonstration is apt to be less violent, because the shunt machine keeps on running in the same direction as a motor that it did as a dynamo. In either case, however, the brushes spark, and under certain conditions the disturbance is so great that the machine gives out a howl and the current jumps over to the frame of the dynamo or arcs from one brush-holder to the other. The brushes give trouble because they are set ahead to run sparklessly when the machine is a dynamo; as soon as the machine becomes a motor, the non-sparking point shifts, leaving the brushes to short-circuit coils that are in an active part of the field.

Lessons in Practical Electricity

ALTERNATING-CURRENT DIAGRAMS.

If a polarized current indicator could be made so free from inertia as to follow the rise and fall of an alternating current like the piston of a steam engine indicator follows the rise and fall of steam pressure, a pencil attached to its needle or pointer and arranged to move to and fro across a moving strip of paper would trace the "current wave" of the generator when the instrument was inserted in series with the circuit; connecting the instrument across the brushes would cause the pencil to trace the "e.m.f. wave" of the machine. For convenience in calculation, these curves are assumed to have the form of a sine curve, as shown by Fig. 1. In practice many machines do give a wave which approaches very closely to a true sine curve.

In Fig. 1 the spaces along the zero or datum lines may be considered intervals of time in fractions of a second. With a frequency of 100 cycles per second, it requires only 1/100 second for a complete cycle, which consists of one positive and one negative impulse, from zero back to zero. Considering the horizontal divisions as intervals of time, the vertical lines would indicate instants 1/1600 second apart, as indicated by the figures on the diagram. If there were no such thing as phase difference the curve diagram would fulfill all requirements, but when currents or electromotive forces, or both, rise from zero to maximum at different instants of time their mathematical relations cannot be so readily determined from curves as from a system of vectors.

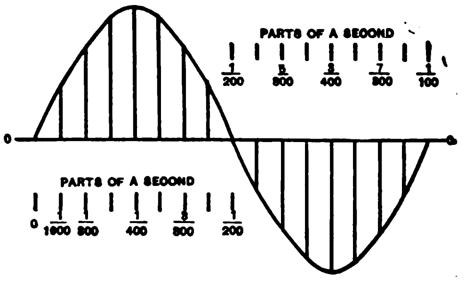


FIG. 1.—SINE CURVE THROUGH ONE CYCLE.

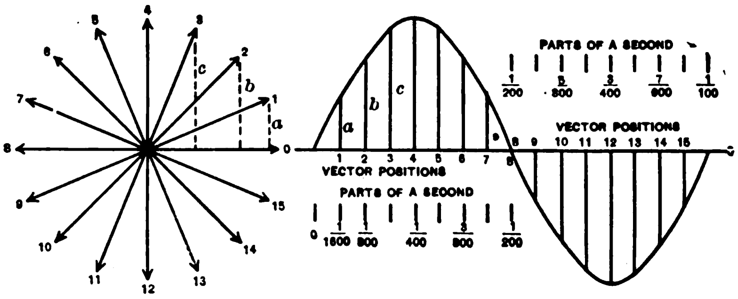


FIG. 2.—SHOWING RELATION BETWEEN E.M.F. VECTOR AND THE SINE CURVE

For convenience, therefore, a cycle, or complete reversal of current or e.m.f. as indicated by Fig. 1, is represented by the rotation of a "vector" about its origin, just as the hand of a clock rotates about the spindle, one revolution representing a cycle. The length of the vector is made to represent the maximum value of the e.m.f. or current, as the case may be, and the distance from the zero line to the outer end of the vector, measured vertically, represents the value of the e.m.f. or current at that part of the cycle indicated by the position of the vector. The latter is usually assumed to rotate left-handedly or counter-clockwise. Fig. 2 shows the relations between the position of the vector and the time intervals of the cycle. Sixteen positions are shown, for simplicity, but it will readily be understood that if the circle described by the vector be divided into 360 parts, as a circle is usually divided, the relation holds throughout, for each degree or fraction of a degree.

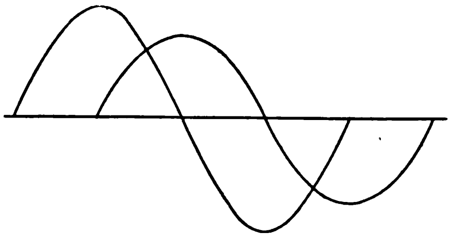
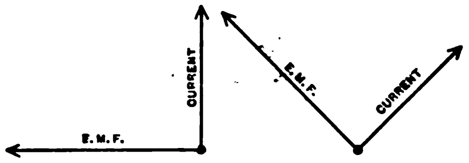


FIG. 3.—CURRENT LAGGING 90 DEGREES.

If the current in a line lags behind its e.m.f. to such an extent that it does not attain its maximum value until the e.m.f. has fallen back to zero and is about to reverse, as indicated by Fig. 3, it evidently lags one quarter of a cycle; that is, the e.m.f. passes through zero one-fourth of a cycle ahead of the reversal of the current. This condition is shown by two vectors having a common origin but being angularly displaced by a fourth of a circle, as shown by Fig. 4. The current is then said to lag 90° (one-fourth of a complete circle), or to be "out of phase" with the e.m.f. by 90°. In comparing phases the zero line is usually omitted, as the object of the diagram is to show merely the phase relations and not the instantaneous values. Consequently it does not matter whether the diagram be drawn as in Fig.

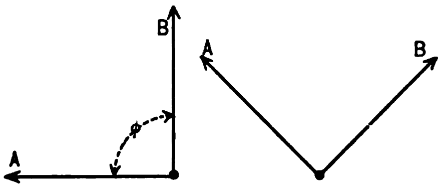


FIGS. 4 AND 5.—VECTORS CORRESPONDING TO FIG. 3.

4 or as in Fig. 5. The main point is the difference in phase.

Differences of phase between two or more e.m.fs. or currents are also represented by vectors. For example, a two-phase (or more accurately, quarter-phase) generator supplies two distinct electromotive forces which are of equal value but a quarter of a cycle apart in phase; that is, when one is at zero the other is at maximum. This relation is shown by two vectors of equal length 90° apart, as in Fig. 6. As in the previous case, it does not matter whether one is horizontal and the other vertical, as in Fig. 6, or whether each forms an angle of 45° with the vertical, as in Fig. 7, or what their position in space is; the point is that they are 90° *from each other.*

The chief convenience obtained by the use of vectors in alternating-current work is in computing the combined effect, or, to express it properly, the resultant, of two or more e.m.fs. or currents which differ in phase. For example, if the two e.m.fs. represented by the vectors, A and B, in Figs. 6 and 7, are connected in series, the resultant e.m.f. may be plotted by drawing two lines parallel with the two vectors, as indicated by the dotted lines in Fig. 8, and drawing in a diagonal across the square thus formed. The diagonal, C, represents both in length and phase relation the resultant of the two original e.m.fs., A and B. If these e.m.fs. are 100 volts each, the resultant, C, will be 141 volts, and it will be ⅛ cycle or 45° ahead of the e.m.f., B, and the same distance behind the e.m.f., A.



FIGS. 6 AND 7.—EQUAL E.M.FS. 90 DEGREES APART.

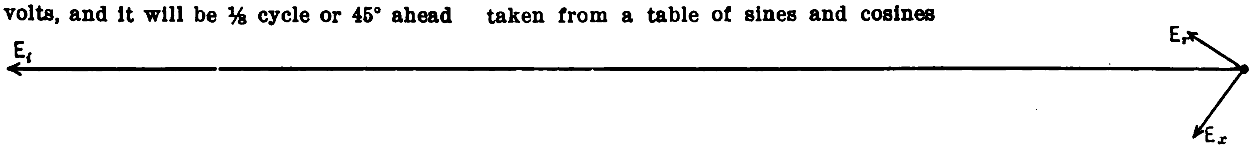


FIG. 12.—VECTOR REPRESENTATION OF THREE E.M FS. HAVING DIFFERENT VALUES AND DIFFERENT PHASES.

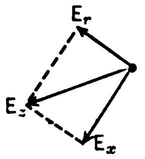


FIG. 13.

The formula for the resultant of two equal e.m.fs. differing in phase and connected in series manner is:

$$2 \times A \times \cos(\tfrac{1}{2}\phi),$$

ϕ being the phase angle between the two e.m.fs. This formula applies regardless of the phase difference, but is only applicable to two e.m.fs. of equal value.

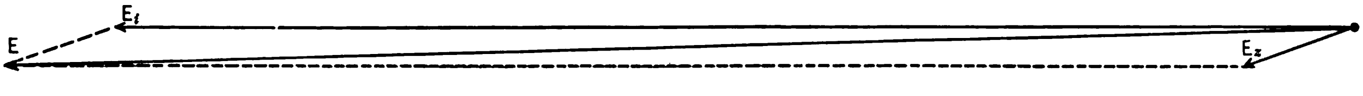


FIG. 14.—RESULTANT OF THE THREE E.M.FS. SHOWN BY FIG. 12.

When two e.m.fs. having different values are combined, as indicated by Figs. 9 and 10, if they are at right angles or 90° apart, the formula for the resultant is:

$$\sqrt{A^2+B^2}=C.$$

This is a case frequently met in practice in calculating the e.m.f. necessary to be applied to the terminals of an inductive load, such as an electro-magnet, on an alternating-current circuit. The vector, B, in the diagrams represents the e.m.f. required to overcome the resistance of the winding, and the vector, A, represents the e.m.f. required to overcome the reactance or inductive opposition, which is always 90° from the resistance e.m.f. The vector sum of these two is the e.m.f. required at the terminals of the coil. For example, the diagram is plotted to a scale of six volts for A and eight volts for B, and the vector sum of these two, instead of being 14 volts, which is the arithmetical sum, would be 10 volts. The scale of the diagram is one-eighth of an inch per volt, and a scale applied to the vector, C, will show that it is 10/8 long, corresponding exactly to the result of the formula.

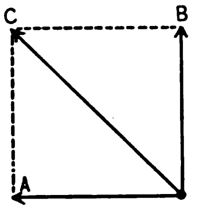
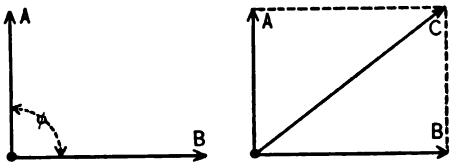


FIG. 8.—COMBINING EQUAL E.M.FS.



FIGS. 9 AND 10.—UNEQUAL E.M.FS. 90 DEGREES APART.

When the difference in phase between the two e.m.fs. or currents is other than 90°, and the two e.m.fs. or currents have also different values, as indicated in Fig. 11, the calculation is more complicated, the formula being:

$$\sqrt{A^2+B^2+2\,AB\cos\phi}=C,$$

in which ϕ is the angle between the two vectors, A and B, as indicated in the diagrams. The cosine of any angle may be taken from a table of sines and cosines such as the various engineering handbooks contain.

When three or more e.m.fs. of different phases are to be combined, two of them are first combined, then the result of these two is combined with the third, and so on, until all are combined. The commonest case of this kind is found in a transformer diagram. Fig. 12 is a part of such a diagram relating to the primary winding; the vector, E_r, represents the voltage required to overcome the resistance of the primary winding, and which is in phase with the primary current; E_x is the e.m.f. necessary to overcome reactance, which is 90° from the resistance drop, as already explained, and E_i is the e.m.f. required to overcome the counter e.m.f. of the transformer. The resultant of these three will be the e.m.f. required at the terminals of the transformer, as this must balance all of the internal e.m.fs.

The first operation is to combine E_r and E_x; the resultant of these two is E_z, as shown by Fig. 13, and this vector represents not only the strength but also the phase of the resultant e.m.f. Having resolved E_r and E_x into E_z, this must be combined with E_i, as shown in Fig. 14, giving the resultant E, which is the vector sum of E_r, E_x and E_i.

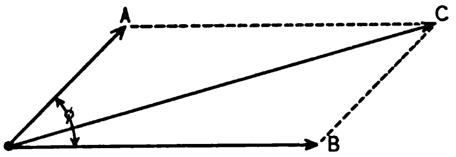


FIG. 11.—UNEQUAL E.M.FS. LESS THAN 90 DEGREES APART.

The reader will find it profitable to make a memorandum of the general rule that vector diagrams and calculations apply to e.m.fs. connected in series and currents combined in parallel; also, all of the currents and e.m.fs. treated in a given diagram or formula must have the same frequency.

Letters on Practical Subjects

Circuit Protection on the Three-Wire System.

To the Editor, American Electrician;

Sir:—The Washington Water Power Company at Spokane, Wash., has its power station near the center of the city and operates an Edison three-wire system for the business part of town. The greater part of the load is carried most of the time by a 750-kw. 300-volt generator connected to the outside of the three-wire mains, two smaller 150-volt generators also being run in order to take care of any unbalancing of the system. If a heavy short-circuit should occur on one side of the three-wire system with such a large generator running connected to the outside mains, the result would be disastrous, as the full 300 volts would be concentrated on one side, which is intended for only 150 volts. To prevent this mishap, John B. Fisken, superintendent of the power and light departments, has inserted in the neutral lead a circuit-closing coil which, upon the occurrence of a short-circuit on either side of the system, will close a local circuit through a magnet, which in turn will trip the main circuit-breaker of the 750-kw. machine.

C. R. James.

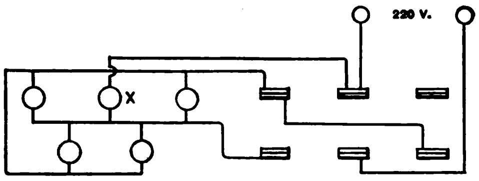
Spokane, Wash.

Another Answer to the Wiring Puzzle.

To the Editor, American Electrician;

Sir:—Regarding the wiring puzzle by Mr. Havens which was published in your December number, I offer the solution shown by the accompanying diagram, which fulfills all the conditions stated in Mr. Havens' letter. Arthur Barthels.

San Francisco, Cal.



WIRING PUZZLE SOLUTION.

[Mr. Barthels' letter and diagram were received several days before the January number containing the other solutions was issued, but were crowded out by lack of space.—Editor.]

Electric Bells on 110-Volt Circuits.

To the Editor, American Electrician;

Sir:—The methods of operating an electric bell from a lighting circuit which have been described recently in this department are very interesting and ingenious. The writer takes the liberty of suggesting, however, that the method shown in the enclosed sketch is rather more practical than the others. The advantages are that the push-button and the vibrator of the bell do not have to deal with a high-tension current, and that the lamp or lamps may be used for illuminating purposes instead of serving as idle resistance. Fig. 1 shows the arrangement for a 110-volt circuit; Fig. 2 shows a similar arrangement for a 220-volt circuit, and Fig. 3 the arrangement for a 500-volt circuit. In all three cases the resistance coil would consist of a few feet of 30 per cent German-silver wire of No. 20 gauge; 15 or 20 feet would be ample. The wire should be wrapped around a stick of porcelain so that it cannot sag and short-circuit its convolutions under the influence of the heat. If the distance from the bell to the point, A, in the diagram is shorter than the distance from the bell to the electric-light mains, then the return wire would be run as shown by the dotted line from A to the bell instead of from the bell to the lighting circuit.

Denver, Colo. Ed. S. Morgan.

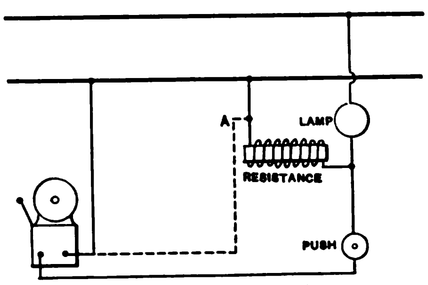


FIG. 1.—BELL ON 110-VOLT CIRCUIT.

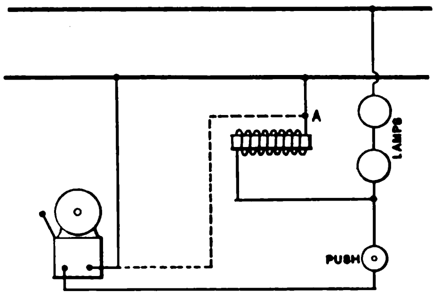


FIG. 2.—BELL ON 220-VOLT CIRCUIT.

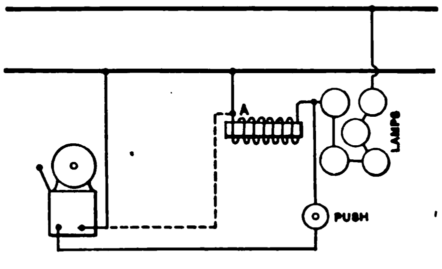


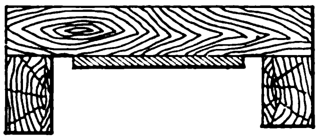
FIG. 3.—BELL ON 500-VOLT CIRCUIT.

A Plain But Efficient Trolley.

To the Editor, American Electrician;

Sir:—Electric locomotives are used for hauling ore and fuel cars for charging furnaces around the Boston & Montana copper smelter at Great Falls, Mont. In fact, electric power is used throughout, as the company owns the water rights of the falls and built its smelter with that power in view. The locomotives are similar to mine locomotives and the trolley which has been evolved as most suitable for the place is interesting. Nothing exposed so that men would hit it with their iron rods, which they have around the furnaces, would do. The trolley conductor is now a flat copper strip in an inverted wooden trough, and the trolley is simply a flat piece on the end of the trolley pole. The curves are very short, but no attention is paid to the trolley. It stays in the trough and looks after itself. Fig. 1 shows the trolley trough.

Ed. B. Cheatham.



TROLLEY TROUGH.

Exhaust Steam Heating vs. Condensing.

To the Editor, American Electrician;

Sir:—In your January issue appears a note to the effect that the St. Joseph (Mo.) Railway, Light, Heat and Power Company has installed an exhaust steam-heating system for the purpose of serving certain buildings where they can get the contract for lighting and heating, but would be unable to get the contract for lighting alone. In this plant the engines are operated condensing in summer and non-condensing in winter when the exhaust steam is utilized for the heating service referred to. It is further stated that the income from this heating service is about equal to the additional cost of coal required when running non-condensing. The natural inference is that this method is a good one, and that if there is any considerable number of such buildings it would be a profitable investment to go into the heating business for the sake of securing the lighting business, if the income from the heating service will pay for the additional coal required when running non-condensing.

It appears to me that with coal balanced against income, the heating service must results in a very heavy loss, and not improbably a loss that will more than balance the profit on the lighting. In addition to the cost of coal, there is the interest on the investment in the heating mains, together with an allowance for depreciation and repairs. There must also properly be charged the interest and the cost of maintenance and operation for a larger steam plant than would otherwise be required. A compound condensing engine with an economical rating of 500 indicated horse-power and a maximum ability of about 750 indicated horse-power will have an economical rating of about 400 indicated horse-power and a corresponding maximum rating of about 550 indicated horse-power when running non-condensing. The mere fact, therefore, of running non-condensing seriously diminishes the normal capacity of the plant and, still more seriously, its overload capacity. If there is any back pressure due to the operation of the heating service, then the economical and overload capacity is still further diminished.

It follows from this diminution of capacity that if a plant is just able, running condensing, to carry its maximum load—which will usually be imposed during the season when the exhaust steam is most required for heating—its capacity must be increased by at least 25 per cent, and probably more, in order to carry this maximum load when running non-condensing and exhausting against a back pressure not exceeding two pounds by gauge. If, on the other hand, there is sufficient generating capacity to carry this maximum load when running non-condensing, it follows that by running condensing the electrical output can be increased 25 per cent or more, without the investment of a single dollar for generating apparatus. In any event, an excess of generating capacity must be provided if the plant is to be run non-condensing in winter, and that excess of capacity represents an investment on which interest must be paid the entire year, together with a charge for maintenance and repairs.

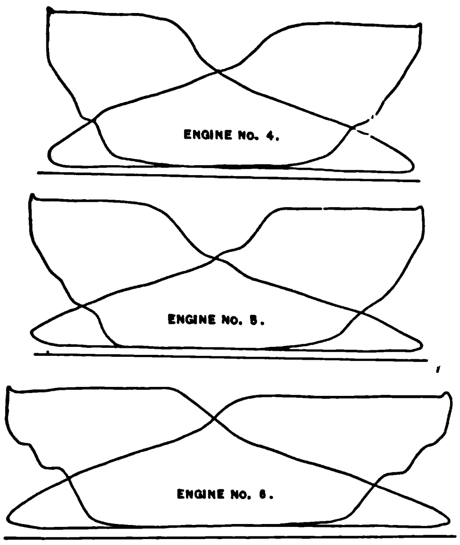
Consequently, in order to derive any profit from the plan under discussion the income from the heating service must cover not only the extra cost of coal required to run non-condensing but the interest on and maintenance of the heating plant, and either the interest and maintenance charges on the excess of generating plant required for the load or the loss of lighting income due to the reduction of the capacity of the generating plant.

New York. A. M. Earl.

Irregular Indicator Diagrams and a Transformer Trouble Remedied.

To the Editor, American Electrician;

Sir:—Referring to the diagrams submitted by L. S. C. in your November number, it seems to me that the wavy compression lines are caused by a sticky indicator movement. They might be caused by the chattering of the valve during compression if the valve was of the plain slide form, but this is not likely. The reason diagram No. 4 is shorter than No. 5 is because the reducing motion was not adjusted exactly the same for both engines. Something must have slipped in changing the outfit from one engine to the other.



IRREGULAR STEAM ENGINE INDICATOR DIAGRAMS.

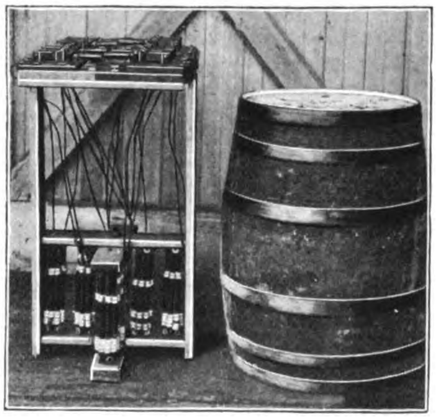
I am running an alternating-current station and was troubled for a long while by the heating of a small three-wire transformer that fed a twenty-four hour consumer. During the day it would run hot enough to boil eggs, but at night, when the full load was on, it would cool down. After burning out two transformers we began a hunt for the cause of the trouble. The lights were tapped off from the three-wire main on two-wire branches and we found that it just happened that nearly all of the lamps that were kept burning in the day-time were fed from the same side of the three-wire main. In the day-time, therefore, the load was almost all on one side and at night it was balanced. By swapping around the taps we divided up the day load as well as the night load and there hasn't been a sign of trouble since. Elmer K. Swift.

A Water Cooled Rheostat.

To the Editor, American Electrician;

Sir:—The writer has noticed in several issues of your paper various descriptions of water rheostats for absorbing large amounts of electric energy. In all of these the water (containing a salt to reduce its resistance) is used as a conductor. The main difficulty with this form is that the temperature of the water rapidly rises, reducing its resistance and keeping the current constantly fluctuating, so that it is difficult to secure accurate measurements. The water rheostat also requires constant attendance, if the current is kept at a fixed value, and is not adapted for operating continuously any length of time.

The writer, in testing some large power meters, met with the difficulties mentioned, and consequently designed a simple apparatus, which is believed to be in some respects an improvement over the form mentioned. It consists of bare German-silver wire 88 mils in diameter wound and secured in sections on a frame, as shown (the coils were originally resistance coils in old-style T.-H. constant-potential arc lamps), with the terminals brought up to double-pole switches on a board above the frame. The frame and coils are submerged in water in a common oil barrel. The water being in contact with the coils absorbs a considerable part of the electrical energy so that the temperature of the coils cannot rise much above 212° Fahr. With a constant e.m.f. the current will remain practically constant for a long period of time, and can be adjusted to desired values by cutting coils in or out and connecting them in multiple series. The immersed rheostat shown in the picture will absorb 150 kilowatts at 220 volts.



WATER COOLED RHEOSTAT.

Chester, Pa. Geo. N. Tidd.

Effect of Reversing a Field Coil on a Multipolar Generator.

To the Editor, American Electrician;

Sir:—The writer recently tried the experiment of running a direct-current six-pole generator with the connections of one of the shunt field coils reversed. The machine was a 125-volt dynamo and was run at a speed which would have given about 150 volts at the brushes under normal conditions. With all the resistance cut out of the field rheostat there was an e.m.f. of 50 volts at the brushes. The machine was run without any load for 10 or 15 minutes without any excessive heating being apparent. It might be that since the field was very weak the current in the armature reacted on the reversed pole in such a manner as to either kill the field there or reverse it. I have erected several machines of different kinds and have frequently found field coils reversed in this way, but have never before made a deliberate test to see what the difference in voltage would be.

Pittsburgh, Pa. B. Graham.

Electrical Catechism

562. *What is the difference between single-pole and double-pole cutouts?*

Cutouts are generally made double-pole —that is, so that there is a fuse on each side of the circuit to give protection against heavy currents whether caused by a "short-circuit" on the line itself, or caused by two ground connections in different parts of the circuit. In the case of large currents at high potentials, it is common to use two single-pole cutouts, in order to maintain a safe distance between the two sides of the circuit. Three-wire systems require a fuse in each of the three wires at each branch.

563. *What is a fuse panel?*

In wiring buildings it is common to use the "cabinet system," in which the various circuits radiate from one or more centers. The fuses and sometimes many of the switches are grouped in the distribution boxes or cabinets. When fuse blocks are used, it is customary to use asbestos lined boxes for the cabinets. In the better class of work, the switch and fuse terminals are mounted upon a marble or slate base, thus reducing the number of connections and making a neater job.

564. *What kind of fuses are used on telephone and similar lines?*

The ordinary currents used on such lines are so small that foreign currents of less than one ampere may cause much damage. The fuses must therefore be very sensitive, so that ordinary electric light fuses are of little or no use. A form frequently used is a small piece of fuse wire mounted on a strip of mica with copper terminals. Another form has a small wire tied in a knot so that its weight will break the fuse if it gets too hot. The McBerty "thermal arrester," illustrated by Fig. 1, is used by the Bell companies; it contains a rubber cylinder, B, in which are a number of turns of fine high-resistance wire

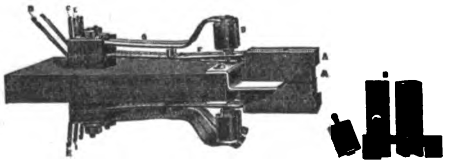


FIG. 1.—McBERTY THERMAL ARRESTER.

in which a stray current will generate so much heat as to melt the special solder and allow a spring, G, to push the central pin against a small spring, F, which connects the line with the earth. A is a lightning arrester with a plug of fusible metal which melts and grounds the circuit if a large current comes in and jumps to the ground across the gap in the mica. The line is connected at D and the exchange or instrument at E, the central iron support being grounded. The cut shows four heat coils for both sides of two circuits.

565. *What sort of fuses do the independent telephone companies use?*

They use a great variety of fuses. One of the best is the form shown by Fig. 2, in which some high resistance wire is doubled up inside a plug of wax in which also is fastened a loop of cord. A grasshopper spring pulls against the cord which is held in place by the wax plug. An excess current will soften the wax and let the plug slip through the ring, when the spring flies out and breaks the fine wire. In an earlier form, the spring tripped a second spring which threw the whole fuse and supporting strip from the holder.

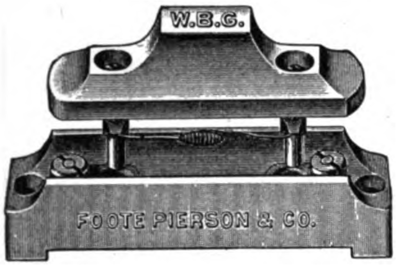


FIG. 2—TELEPHONE FUSE.

566. *Are fuse wires adaptable for fire alarms?*

Fusible metal has been applied in several ways to the extinguishing of fires by opening sprinklers when the temperature exceeds a definite degree. The same idea has been applied in the "Montauk" cable for giving an alarm under similar circumstances. The cable consists of a number of conductors, the inner one of which is surrounded by an alloy that fuses at about 370 degrees Fahrenheit. If the cable is exposed to a high temperature, such as might be caused by an incipient fire, the fusible alloy melts and completes the circuit between the central wire and those near it, thus sending in an alarm through an electric bell or similar device.

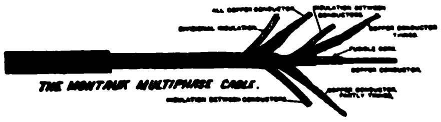


FIG. 3—FUSIBLE CABLE.

567. *For what useful purposes is the heating effect of the current employed?*

The heating effect is used in safety devices such as the fuses noted above (see Q. 550 to 566). Moderate degrees of temperature are used in heaters of various sorts, such as stoves, heating pads, tea kettles, coffee pots, ovens, smoothing irons, curling iron heaters, soldering coppers, solder or babbitt melting pots, glue pots, branding irons, stamp cancellers, surgeons' cauteries and the like. Higher temperatures are used in the tempering of steel, in blasting fuses, in incandescent lamps, arc lamps, electric welding and forging and in various electro-metallurgical processes. Applications of the heating effect of the current are developing continually. The heating effect of the current is used to a small extent in electrical measurements. Heat is developed incidentally in connection with rheostats for regulating or absorbing electrical energy.

568. *What is a blasting fuse?*

A blasting fuse is illustrated by Fig. 4 in which a small platinum wire, E, may be heated by a current and so ignite an explosive mixture, B, which will ignite a still larger charge outside the fuse. Current enters and leaves through the wires, C, which are long enough to extend beyond the surface of the hole. As many as forty of these fuses may be connected in series and fired simultaneously. Current is usually furnished by a small magneto dynamo similar to but more powerful than those used for ringing telephone bells.

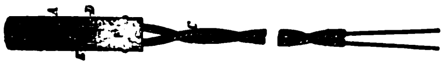


FIG. 4.—BLASTING FUSE.

569. *What is a rheostat?*

A rheostat is a conductor arranged to dissipate electrical energy into heat. It may be used simply to regulate the resistance of the circuit of which it is a part, it may be to regulate the current by changing the resistance of a circuit, it may be to dissipate energy as in a test, it may be to develop desirable heat from electricity. Usually the rheostat is so arranged that its resistance may be changed at will.

570. *For what purposes are rheostats used?*

Rheostats are connected into the field magnet currents of dynamos to regulate the electromotive force of the dynamo; they are used in series with motors to make them start slowly; they are sometimes used in the field circuits of motors to regulate the speed; they are sometimes used to absorb the power of a dynamo while being tested for capacity and efficiency; they are used to regulate the current in a great variety of apparatus supplied from circuits of constant potential. Rheostats are sometimes used to vary the difference of potential between the terminals of apparatus on constant potential circuits.

571. *Of what material are the conductors in rheostats composed?*

Metallic wire is most common, although carbon and graphite are used sometimes; and it is not unusual to employ water made conducting by the addition of salt or acid. Iron is cheap and will stand a high temperature. Copper has high conductivity and is convenient where large currents at low voltage must be controlled. German silver has high resistance and low temperature coefficient, and is used where the resistance must be kept constant.

572. *How are the conductors supported in rheostats?*

Where the energy is small, as in telegraph systems and in standard resistances in wheatstone bridges and similar laboratory apparatus, the wire may be wound in coils directly upon wooden spools. Where there is liable to be considerable heat, the conductors must be supported on noncombustible material, as is required by the insurance rules covering the use of electricity for lighting and power purposes. The conductors may dissipate their heat into the open air directly or through another surrounding medium such as enamel, which carries the heat to cast-iron base plates. The conductors may be wound on slate slabs; on a framework of iron rods insulated with asbestos, or on insulated metallic spools with layers of asbestos between the layers of wire; the wire may be wound into coils which are stretched between insulators on a frame of iron or of insulating material. When the rheostat is to be used for only a short time, the wire is sometimes wound on spools, as such method allows a large amount of wire in small space, and the capacity of such a rheostat depends more on its capacity for taking up heat than on radiation and convection. When spiral coils are employed, provision is made for free circulation of air. Sometimes asbestos tubes are placed inside coils of small wire for the purpose of keeping them still, while the convolutions are close together. In some cases the resistance wire in small rheostats is wound on flat "cards" of mica or fuller board, which are then bent and packed closely together.

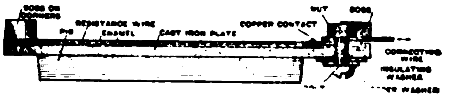


FIG. 5.—SECTION OF RHEOSTAT.

573. *How is the resistance of a rheostat varied?*

The conductors are generally all in series and connections are made at various points with contact blocks upon which a moving arm sweeps so as to include more or less of the resistance, as suggested in the figure. Sometimes the resistance is reduced while the carrying capacity is increased by putting more or less resistance units in multiple, as when a bank of incandescent lamps is used for regulating a current.

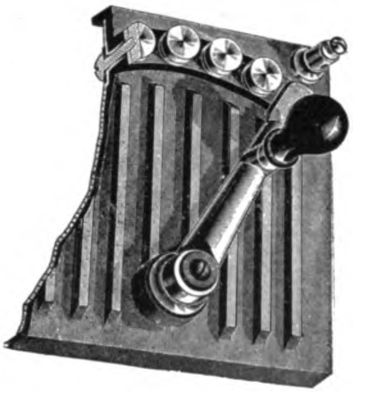
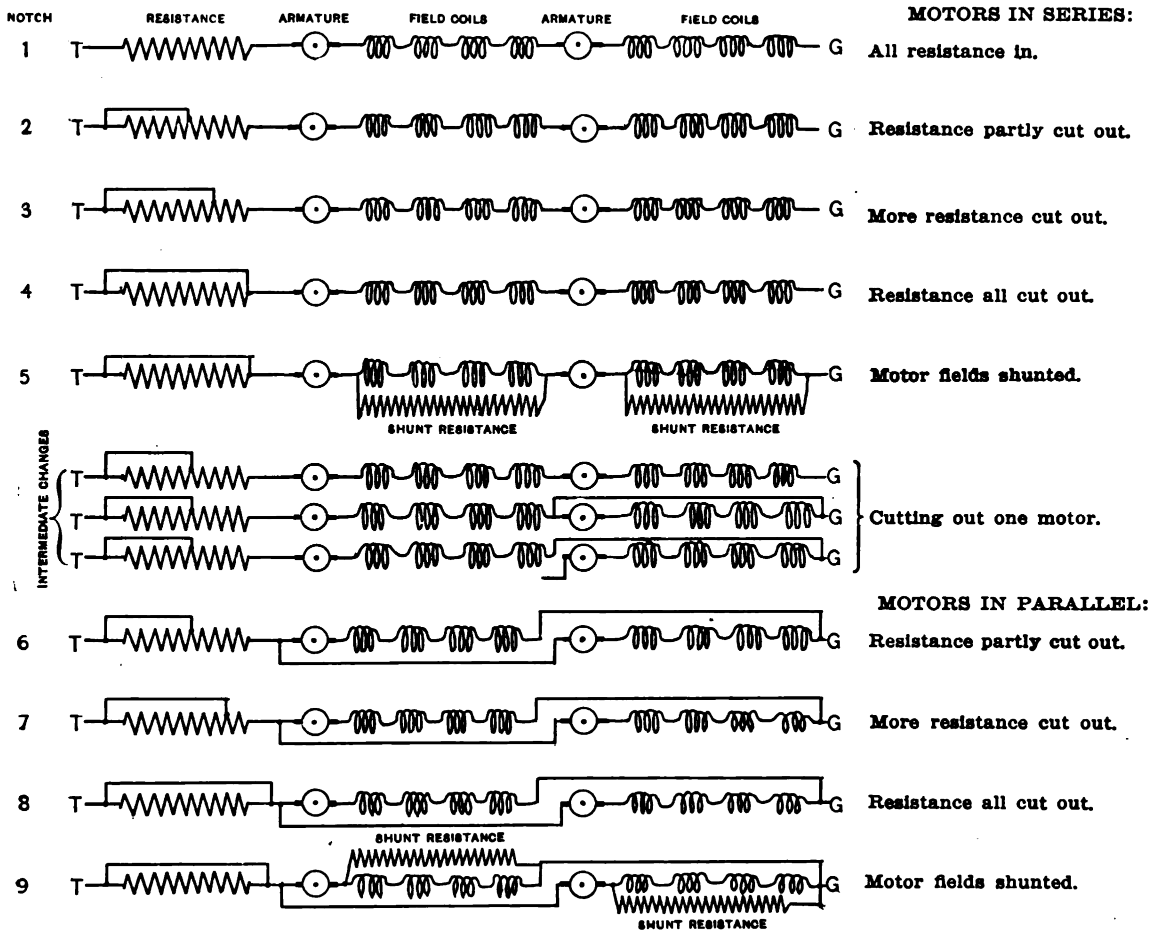


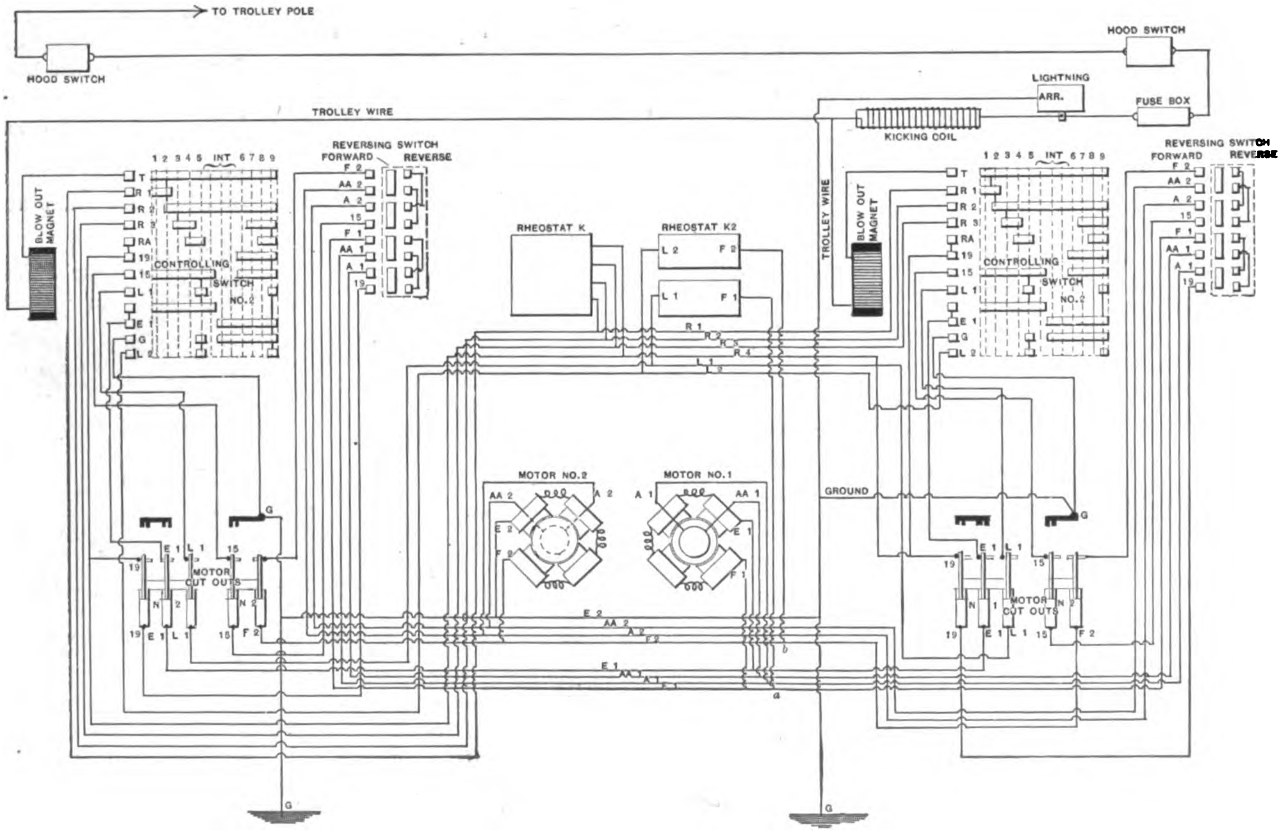
FIG. 6—RHEOSTAT WITH MOVING ARM.

DIAGRAMS OF ELECTRICAL CONNECTIONS.

K2 CAR CONTROLLER.


NOTCH
RESISTANCE
ARMATURE
FIELD COILS
ARMATURE
FIELD COILS
MOTORS IN SERIES:
1 T G All resistance in.
2 T G Resistance partly cut out.
3 T G More resistance cut out.
4 T G Resistance all cut out.
5 T G Motor fields shunted.
SHUNT RESISTANCE
SHUNT RESISTANCE
INTERMEDIATE CHANGES
T G
T G
T G
Cutting out one motor.
MOTORS IN PARALLEL:
6 T G Resistance partly cut out.
7 T G More resistance cut out.
8 T G Resistance all cut out.
SHUNT RESISTANCE
9 T G Motor fields shunted.
SHUNT RESISTANCE

Electrical Relations at Each Notch of the Controller.



Wiring Diagram for K2 Controller.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

What causes some arc lamps to burn with a violet color while other lamps on the same circuit give a yellowish-white arc?
R. L. T.

The difference in the adjustment of the arc. A lamp with a long arc will give a bluish light. In order to get rid of the bluish tinge the arc must be shortened.

Can an electric call bell be connected on a railway circuit of 550 volts, tapping from a group of five incandescent lamps in series?
W. H. B.

The call bell circuit cannot be tapped directly from the series of incandescent lamps. A small resistance of about five ohms should be inserted in series with the five lamps and the call bell circuit connected in shunt to this resistance.

Is there any way by which direct current of 100 volts and 30 amperes can be transformed to 600 amperes and 5 volts without the use of a motor-generator? I wish to make the change for convenience in testing meters.
L. C. S.

The only other way is to use a storage battery of 50 small cells, grouping them all in series for charging and grouping them in multiple-series for discharging. This, however, is vastly more inconvenient and considerably more expensive than to use a motor-generator.

How can I tell the number of kilowatts delivered to a circuit by means of a Thomson recording wattmeter?
G. M. D.

Allow the meter to run ten minutes, then take its net reading, which will be the energy delivered in watt-hours during the ten-minute run. Multiply this reading by 6 and you will have the average number of watts delivered to the circuit; dividing this by 1000, of course, gives you the kilowatts.

Will a ½-h.p. kerosene engine be large enough to drive a small dynamo giving 8 amperes at 45 volts? (2). Is a kerosene engine noiseless, so that it could be used in a house?
A. C. R.

Probably; although it would be safer to put in a ¾-h.p. or 1-h.p. engine. (2). No engine is entirely noiseless. If you are so situated that you can carry your exhaust pipe out into a back yard so as to get the noise of the exhaust out of the house the other noises will probably not be objectionable.

Can storage batteries be charged from a series-wound dynamo; if not, why not?
F. J. P.

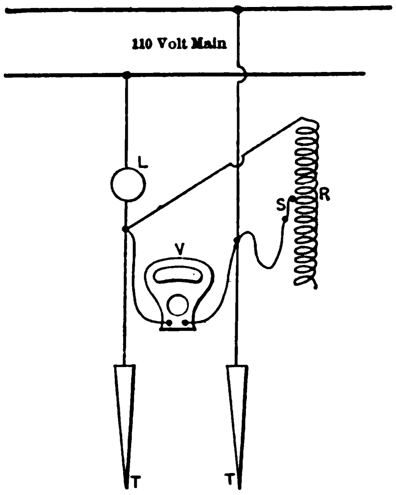
It is not practicable to charge a storage battery from a series-wound dynamo for the reason that as the counter e.m.f. of the storage battery works up it opposes the e.m.f. of the dynamo and reduces the current flowing through it. This weakens the field of the dynamo and reduces its e.m.f., causing a further reduction of the current flow. The operation is cumulative and the ultimate result will be that the battery will discharge through the dynamo. It is possible to counteract this tendency by constantly watching the circuit and strengthening the field of the dynamo as the storage battery increases its counter e.m.f., but this is not a practical method.

I am working in a storage-battery room and find that my clothes are damaged by acid fumes; how can this be prevented?
J. L. S.

The acid spray (not fumes) from a storage battery cannot be prevented from eating cotton goods, but it will not attack woolen; the only remedy, therefore, is to wear woolen clothes throughout.

How is a voltmeter connected up for testing an armature?
H. S. R.

There are several methods of testing for defects in armature windings, one of the commonest of which is shown by the accompanying diagram, in which "T, T" are the testing tips or contacts; "L" is a 110-volt incandescent lamp; "R" is a comparatively small resistance divided into a large number of steps; "S" is an adjustable contact for cutting in and out sections of the resistance coil, and "V" is a low-reading voltmeter. The sliding contact, S, is adjusted along the resistance coil until the voltmeter needle is deflected to the extreme end of the scale when the tips, T, T, are not in contact with anything. The tips, T, T, are applied to commutator segments. In testing for open-circuited coils the plugs, T, T, are applied to successive pairs of segments all around the commutator; one pair will finally be reached which will show a larger deflection at the voltmeter than any of the others; the open coil is the one connected to these two segments. To test for a short circuit coil the tips are applied to the commutator segments in adjacent pairs, as above, until the pair is found which gives the least deflection of the voltmeter needle; the damaged coil will be connected to this pair of segments.



A Westinghouse street-railway motor, after having the armature rewound, ran backward, necessitating the reversal of the armature leads. The coils were wound exactly like the original coils and put on the core in the same way. What was the cause of the trouble?
J. C. F.

Your coils were connected backward to the commutator. That is to say, calling the terminals of the coils right-hand and left-hand, the left-hand terminal was connected to the commutator segment to which the right-hand terminal should have been connected, and *vice versa*.

A direct-current multipolar motor running on a 500-volt circuit blows holes between the commutator segments always at the outer end of the commutator; it has done this with two different commutators. Can you suggest the cause of the trouble and the reason why the holes always appear at the outer end of the commutator?
L. H.

Your trouble is probably due to dampness or else to oil spray on the end of the commutator near the journal; in either case the trouble would appear at the outer end of the commutator because this end is more accessible to both dampness and oil spray than any other portion of the commutator.

I have two small Edison dynamos supplying a three-wire system. Is it practicable to increase the output of the plant by adding a 220-volt dynamo connected to the outer wires of the system, balancing the load by means of two small machines? (2). The two small machines are shunt wound; should they be compounded the same as the large machine, or should the large machine be shunt wound to correspond with the small ones?
W. W. F.

Yes. (2). All of the machines should be shunt wound, as an equalizer cannot be applied between them.

Why does a resistance coil used for reducing voltage waste energy? (2). Is the insulation of a circuit containing thirty 50-volt arc lamps subjected to 1500 volts? (3). Why does a voltmeter made for use on an incandescent circuit fail to indicate when connected to the terminals of an arc lamp in a series circuit?
F. E. O.

Because energy is required to force current through any resistance. If this energy were not absorbed the voltage would not be cut down by a resistance coil on a direct-current circuit. The electrical energy absorbed by the coil is wasted because it is not converted into useful work. (2). Yes. (3). Because it is either damaged or connected up backward. Try reversing the connections between the voltmeter and the arc lamp.

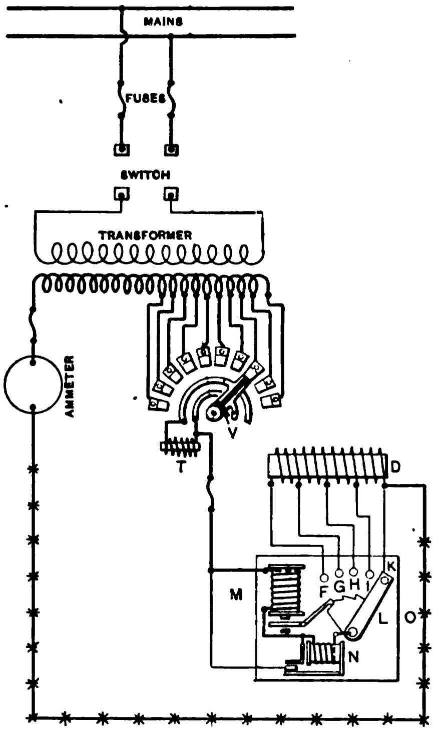
How can I find the number of lines of force passing from the pole piece of a motor to the armature core?
C. C.

Count the number of wires around the circumference of the armature; multiply this number by the revolutions per second of the motor; divide the e.m.f. at the brushes by the product of wires and revolutions, and multiply the result by 100,000,000. The final result will be approximately the number of lines of force, but this will not be accurate because the drop in volts in the armature and brushes has not been taken into account. If you know what the resistance of the armature circuit is from brush to brush multiply this by the current passing through the armature and deduct the result from the e.m.f. at the brushes. This will give you the counter e.m.f. of the motor or the internal e.m.f. of the dynamo, as the case may be; multiplying this by 100,000,000 and dividing the result by the product of the armature wires and revolutions per second will give you the number of lines of force accurately.

A SYSTEM OF REGULATION FOR SERIES ALTERNATING-CURRENT ARC LAMPS.

The rapid adoption of the alternating-current enclosed-arc lamp for operation in series groups from constant-potential primary circuits has resulted in the production of a goodly number of regulating systems, the basic feature of which is a regulator for maintaining constant current through the series of lamps. One of the latest of these systems is that of the Western Electric Company, which is shown diagrammatically by the accompanying illustration. The diagram shows a constant-potential transformer with a tapped secondary winding, the taps being led to contact blocks of a radial switch, the arm of which is indicated by V. This arm is of somewhat peculiar construction, carrying two contact fingers, the ends of which travel over the contact blocks. These two fingers are constantly in connection by means of brushes with the two circular segments shown, to which are connected the terminals of a choke coil, T. The secondary winding of the transformer, of course, is in series with the lamp circuit, and the function of the dial switch just referred to is to vary the e.m.f. of the circuit in accordance with the number of lamps burning. The object of the choke coil, T, is to prevent short-circuiting two adjacent contact blocks of the dial switch as the arm moves from one block to the next.

The arrangement shown in the lower part of the diagram is a combined starting and safety device which is also connected in series with the lamp circuit. It consists of a reactive coil, D, from the winding of which taps are led to the contacts, F, G, H, I and K, of a dial switch, the arm, L, of which is under the influence of a coil spring tending to throw it over to the left, beyond the contact buttons, and thus open the circuit. The lever is held in any position to which it may be moved by means of the ratchet segment and pawl shown in the diagram. The pawl is held in engagement with the ratchet by the magnet, M, so long as current is flowing through the circuit. Should the circuit open or the current supply be discontinued, the armature of the magnet, M, will be drawn downward by a spring, not shown, releasing the lever, L, and allowing its spring to throw it over to the left and open the circuit. The magnet, N, is a release magnet for excessive current flow, its armature being arranged to short-circuit the winding of the magnet, M, when the current exceeds a predetermined value.



SERIES REGULATOR DIAGRAM.

In the operation of the system the circuit is started up as follows: The arm, V, of the upper dial switch is thrown over to the extreme left-hand contact block, so that when the circuit is closed it will be supplied with the minimum secondary e.m.f. of the transformer. The lever, L, of the lower dial switch is then moved to the first contact button, F, and the main switch, shown in the diagram above the transformer, is closed. The lever, L, is then moved gradually to the right, cutting out successively the sections of the reactive coil, D, until it reaches the position shown in the diagram, where the whole coil is cut out; this ordinarily gives the lamps sufficient current to heat the carbons preparatory to the establishment of the arcs. The lever, V, of the main regulating switch is then manipulated so as to deliver the proper e.m.f. to the circuit to maintain the desired current flow.

◆

TESTS OF SINGLE-PHASE MOTORS.

The accompanying curves were plotted from tests of Wagner single-phase motors made under the direction of Prof. W. S. Aldrich, of the University of Illinois. In both cases are given power factor, efficiency, current and speed test results. In Fig. 1 the curves are carried to full load only, while in Fig. 2 the test was carried to about 25 per cent above the rated capacity of the motors.

While these curves show a maximum output of about 25 per cent in excess of the rated output of the motors tested, it should be noted that the makers provide them with a loop terminal, by the use of which a part of the field or primary turns can be cut out of circuit, thus increasing the output about 25 per cent at normal voltage, enabling the motors to take care of temporary loads up to 150 per cent of their rated capacity when operated on this loop. In some tests for power factor and efficiency of a 5-h.p. 60-cycle motor, made at different voltages, the output was almost directly proportional to the square of the impressed voltage within the limits of the tests, and even at the larger outputs, the power factor and efficiency dropped off only a little.

The above and similar test results which have been reported are serving to remove much of the skepticism which many conservative central station men have entertained relative to the commercial practicability of single-phase alternating current motors, and a very general use of motors of this type seems likely to develop rapidly in those fields where a single-phase motor is either necessary or desirable by reason of its simplicity of installation. The Wagner motor does not depend upon the rotary field principle for its starting torque. It has but a single field-winding, which suffices through the medium of the starting construction employed to start the motor under full load, or even more if desired.

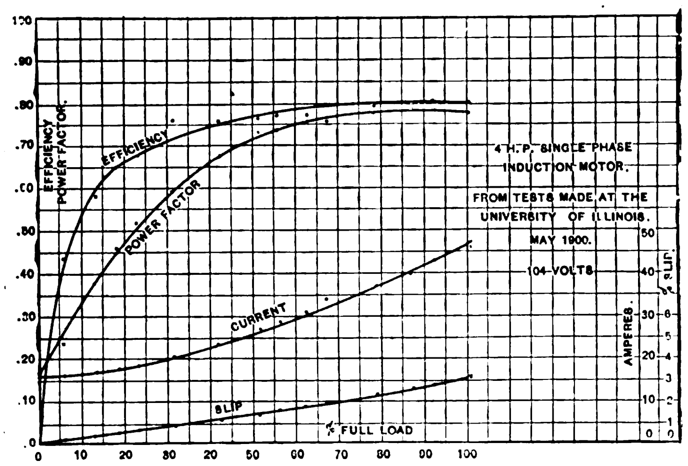


FIG. 1.—CURVES FROM TEST OF 4-H.P. MOTOR.

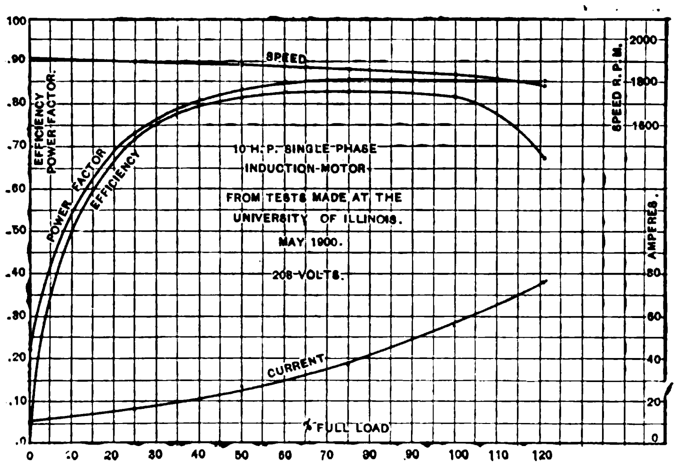


FIG. 2.—CURVES FROM TEST OF 10-H.P. MOTOR.

New Apparatus and Appliances

DIRECT-ACTING PRESSURE PUMP.

Fig. 1 illustrates the latest compound direct-acting pressure pump built by the Stilwell-Bierce & Smith-Vaile Company, of Dayton, Ohio. The pump is one of the largest of its type built, and is designed for a working pressure of 600 lbs. to the square inch. It is intended for mine station work. The valves are of a special bronze and type, seating on steel seats and situated in separate chambers. The water plungers are also of bronze and are of the trombone type, end-packed, reciprocating through deep and accessible glands. The water end is made of a special steel, and is provided with an extension piece having an adjustable shoe for the guidance and support of the plungers. It is mounted on heavy cast-iron feet. The steam end is of the cross-head type, lagged in polished steel, and fitted with Corliss valves. The valve adjustment is on the outside, and the rock-shaft stand which supports the valve gear is so placed as not to interfere with the inspection of the working parts, and also to be free from vibration.

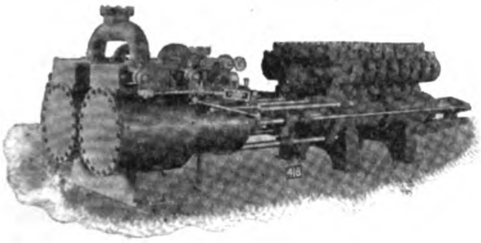


FIG. 1.—DIRECT-ACTING PRESSURE PUMP.

SARGENT GAS ENGINE OILER

The Michigan Lubricator Company, Detroit, Mich., has brought out the oiler illustrated by Fig. 2, and which was designed especially for lubricating the cylinders of gas or oil engines, and also vacuum pumps and air compressors in which the pressure during the induction stroke is slightly below atmospheric pressure. The essential features are a glass reservoir, which is filled through a hole in the top normally covered by the slide A; a needle valve which is adjusted by means of the handle, B, and which controls the feed into the air-tight sight chamber; a ball check valve, D, held to its seat by a spring, the compression of which is adjusted by the nut C. While this is essentially a cylinder oiler, by removing the compression from the spring it may be used in place of the ordinary sight-feed oiler on any other part of the engine. When this oiler is used for admitting oil to the cylinder of a gas engine or air compressor, the check-valve spring is so adjusted that the valve seats when the air pressure above and below the check is the same; but if the air pressure below the check valve is slightly reduced, the check will open and allow the oil in the sight chamber to pass into the cylinder; and the atmospheric pressure on the oil in the reservoir will force the oil down through the needle valve to the sight chamber, from which it will pass into the cylinder every time the check valve opens. When the engine stops, the check valve remains seated and the oil stops feeding through the needle valve, because oil cannot drop into the sight chamber if the air and oil already in there are not drawn out. When compression begins in the cylinder, the check valve shuts and no smoke or pressure from the explosion passes into either the sight chamber or reservoir.

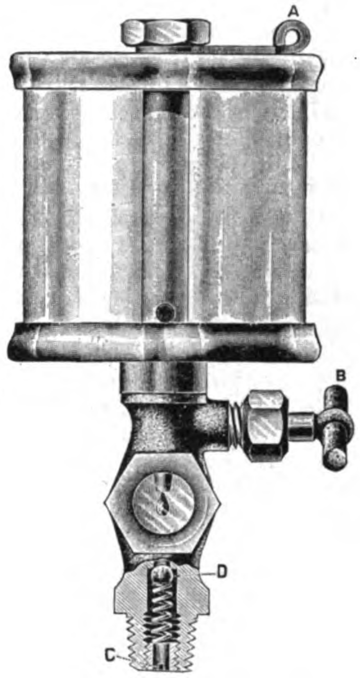


FIG. 2.—GAS ENGINE OILER.

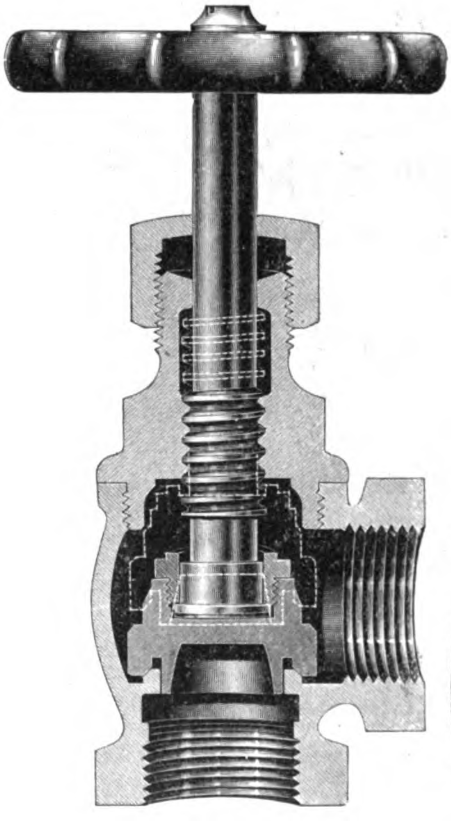


FIG. 3.—BLOW-OFF VALVE

BLOW OFF VALVE AND LOW WATER ALARM.

In order to overcome the trouble generally experienced with the ordinary valves and cocks used at the blow-off, the Crane Company, of Chicago, has designed the blow-off valve illustrated by Fig. 3. It will be observed that the valve seat is situated on the outside, thereby obviating the possibility of sediment lodging at this point. It will also be noticed that there is a projection on the under part of the disc. This projection is added in order to prevent any discharge from taking place until the seats have become widely separated; it also prevents wire drawing. The valves are made in four sizes and in either angle or globe patterns. They should always be connected so that the pressure tends to seat the disc.

The Crane Company has improved its low-water alarm so that it may be readily tested by the inspectors of workshops and factories. A hole is tapped in the top of the boiler to take the bushing, A, Fig. 4. A short piece of pipe is screwed inside of the bushing, and reaches to within 2 ins. of the top of the boiler tubes. The tee, E, is connected by a pipe to the steam space in the boiler. So long as the water does not fall below the low-water line, the water in the pipe, B, prevents the steam from reaching the fusible plug; but when the water does fall below the low-water line steam rushes into the fusible plug chamber, C, fuses the plug and escapes through the hole in the wheel, raising lever, D, which opens the valve in the whistle, F, thereby permitting steam in the pipe, E, to give the alarm. Fusible gaskets are furnished with these alarms, and may be inserted by closing the valve, G, and unscrewing the nut, C. When the

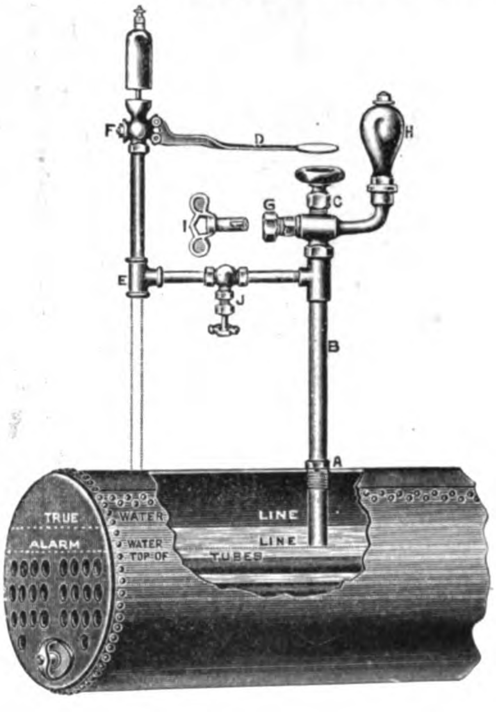


FIG. 4.—LOW WATER ALARM.

parts have been replaced the removal of the key, I, indicates that the valve is open and ready for operation. In testing, the valve, J, is the only one that should be opened. This permits the live steam to pass into B, melt the gasket and give the alarm.

A NEW ENCLOSED ARC LAMP.

Fig. 5 represents the mechanism of a new arc lamp which the National Arc Lamp Company, Lorain, Ohio, is introducing, and which, it is claimed, differs widely from any other type heretofore employed. It is constructed on what is termed the divided coil principle. Around a core of laminated iron is wound a coil in two sections, the larger portion being stationary and the smaller part movable parallel with the core axis. The mutual action of the magnetic fields of the two coils causes the smaller coil to move with reference to the larger one. With this mechanism it is said to be unnecessary to employ an additional choking coil for alternating circuits. It is claimed that this lamp gives as much light on 4½ amperes as is usually obtained from 6 to 7-ampere lamps, and that 100 of the lamps can be operated with the same transformer capacity that is usually allotted for 75 lamps. Another advantage put forward is that the inductive load is greatly reduced. The standard lamp for alternating circuits consumes 4½ amperes at 85 to 90 volts, this being the drop across the arc when the lamp is burning on a 104-volt circuit. The lamp has a power factor of .87. The same type of mechanism is used for direct-current circuits. For 500-volt circuits two 2½-ampere lamps are connected in series and, it is said, will operate successfully on a fluctuating potential within the range of 350 to 650 volts. These lamps are said to be independent of voltage fluctuations on alternating current as well as on direct. The following distinctive claims are made: First, it has no moving iron; second, it has no springs; third, no choke coil is necessary for alternating circuits; fourth, its coils are bolted to the frame, and, fifth, it has a cast aluminum case and hinged outer globe.

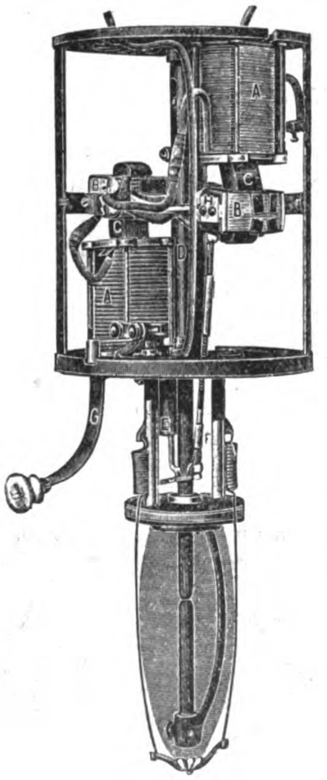


FIG. 5.—ENCLOSED ARC LAMP.

PORTABLE TESTING INSTRUMENTS.

An attractive line of portable testing instruments which should appeal to engineers whose work involves the use of this class of instruments is being manufactured by Elmer G. Willyoung, of New York. Two of these instruments are represented by Figs. 6 and 7 herewith. Fig. 7 is the "P. T." D'Arsonval galvanometer, which is claimed to be the most sensitive galvanometer of this type made in actually portable form. The moving system is mounted between jewels and is dead-beat. The scale is about 2 ins. long and calibrated in 50 divisions. With an e.m.f. of one volt the pointer will show a deflection of one divison when the instrument is working through a resistance from 1 to 1½ megohms. The instrument is provided with three shunts, the connections of which are controlled by the small dial switch shown on the cover of the box. These shunts have ratios of ½, 1/3 and 1/5; four buttons are provided for the switch lever, so that the instrument may be used without any shunt at all or with either one of the three. This galvanometer is also supplied in a box with a battery of test cells, the number of cells being anywhere from 5 to 50, according to the requirements of the user. In this shape the outfit is evidently suitable for insulation tests by the direct reflection method.

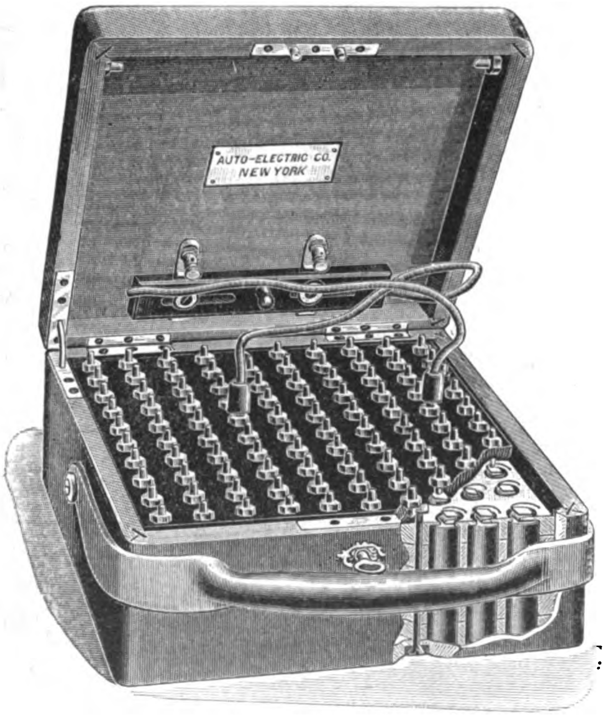


FIG. 6.—"CLOVER LEAF" TEST BATTERY.

Fig. 6 represents the "Clover-Leaf" test battery in the 100-cell size. The individual cell is put up in a drawn (not crimped or soldered) zinc shell ¾ in. in diameter by 2¼ ins. long; this shell constitutes the negative terminal of the cell. The positive electrode is carbon. The e.m.f. of each cell is almost exactly 1.4 volts and this e.m.f. is said to be uniform with all the cells and to remain constant throughout the entire life of the cell. It is stated that there is substantially no deterioration on open circuits, so that the life of a cell is only limited to its service. There is, it is stated, no generation of gases either on open or closed circuit, and therefore no bursting of the cells and possible flooding of delicate instruments with liquid chemicals. Each cell slips into a hole of the proper size in a "built-up" block of light wood. The carbon terminal is a spring brass plate brought out above, and the zinc terminal is a small wire which is carried over to the plate of the neighboring carbon. The external connections are made by means of flexible cords and the usual studs; these are all mounted in a hard rubber plate from which they project below. A suitable number of rods pass through bushings in the bottom of the carrying case and through the built-up block, and are screwed into the under side of the hard rubber plate. By means of these rods the rubber plate is drawn down upon the cell block so as to bring each stud in contact with its own cell plate. Each set is provided with a reversing switch in which the insulation surface is unusually long. The binding posts are all of the double grip pattern, clamping the wire either between flat surfaces or in a hole. Two studs in the lid take the flexible cords when the battery is not in use, thus obviating the unpleasant dangling of cords common with many test batteries.

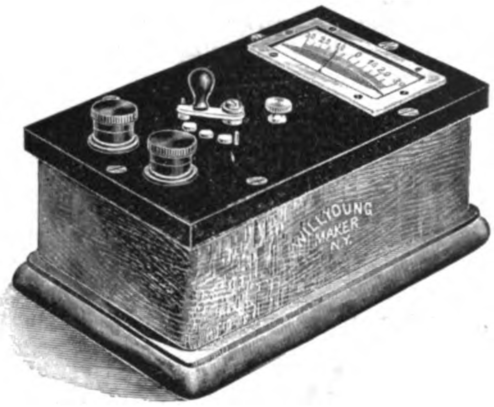


FIG. 7.—"P. T." D'ARSONVAL GALVANOMETER.

GASOLINE TORCH WITH HANDLE AND PUMP COMBINED.

The Clayton & Lambert Manufacturing Company, of Detroit, Mich., has added to its line of gasoline torches a new form known as No. 16, which is illustrated by Fig. 8. The torch is of the standard quart size. The tank is made of heavy drawn brass, fitted with a burner which is said to produce a fine blue flame. The burners are fitted with improved double-shouldered needle points which add to their durability. The pump of the torch is placed within the handle, as may be seen from the illustration. The makers furnish full description with the torch, and a little booklet, valuable to users of gasoline fires.

STEAM HOT BLAST APPARATUS.

A hot blast apparatus which includes an electrically-driven fan and is built by the B. F. Sturtevant Company, of Boston, Mass., is illustrated by Fig. 9. A heater, made up of a series of cast-iron bases into which are screwed steam pipes, is encased in a fireproof steel plate housing. The heads of the sections are bolted together, and either live or exhaust steam is admitted to the common chamber thus formed. A current of air having a high velocity passes over these heated pipes and is distributed throughout the building. In the illustration the fan is also encased in a steel plate housing, drawing air through the heater and having a top horizontal discharge. It is a radial-bladed wheel carried upon an extension of the motor shaft. A special line of electric fans is designed by the company which may be driven independently or in connection with the heating apparatus. The motor in the illustration is of the standard eight-pole type built by the company. According to the conditions and the temperature of the entering air, and of the steam pressure and number of pipes across which the air is drawn, hot air is delivered at a temperature varying from a few degrees above that of the atmosphere to 200° Fahr. The apparatus may also be made to serve as a cooling device in hot weather.

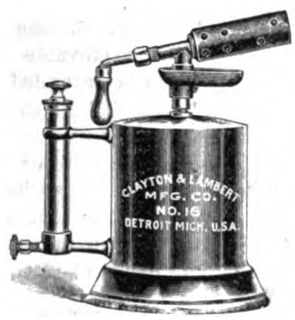

CLAYTON & LAMBERT
MFG. CO.
NO. 16
DETROIT MICH. U.S.A.

FIG. 8—GASOLINE TORCH.

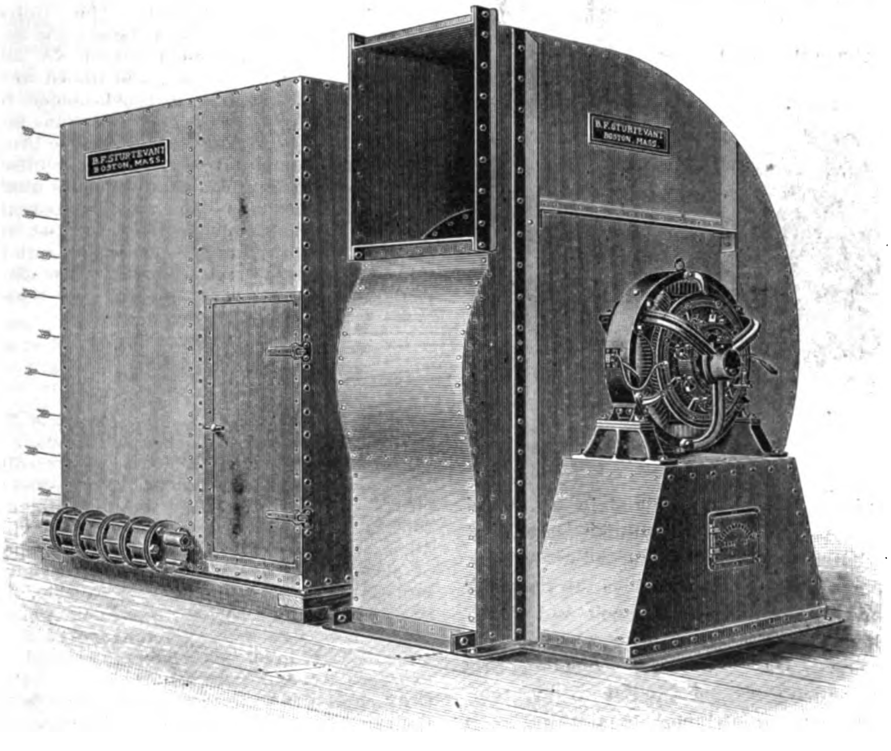

B.F.STURTEVANT
BOSTON, MASS.
B.F.STURTEVANT
BOSTON, MASS.

FIG. 9—STEAM HEATED HOT BLAST APPARATUS WITH ELECTRIC FAN.

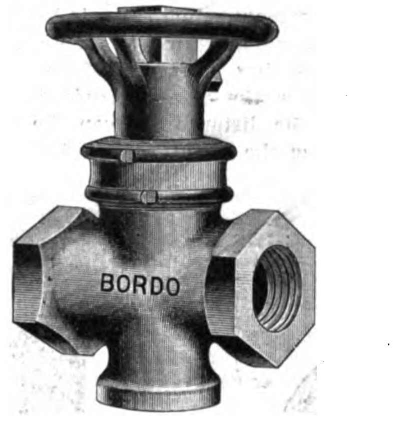


FIG. 10.—BORDO PLUG VALVE.

THE BORDO PLUG VALVE.

The accompanying illustrations show the Bordo plug valve, manufactured by the Bordo Valve Company, of Philadelphia. Its construction can be readily seen from Fig. 11. The plug, which is accurately turned, fits snugly into a tapering seat in the body of the valve. Bearing upon an adjustable bonnet, and fastened with a set screw, is a wheel which is screwed to the stem of the plug. Should this not give sufficient leverage, the stem is furnished with a square head for the application of a wrench. The friction caused by turning the valve is taken up by two brass rings placed around the stem; the upper one, or gland as it is called, being stationary, while the lower one is free to revolve with the gasket. Any wear on the plug may be taken up by simply adjusting the bonnet. The valve is made either flanged or screwed, and in all sizes. Fig. 10 shows an exterior view.

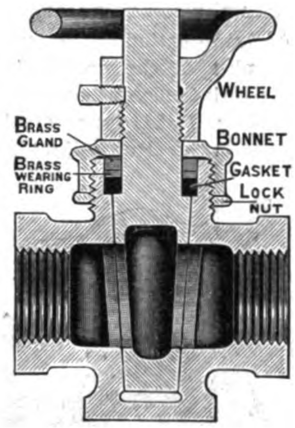


FIG. 11.—SECTION OF BORDO VALVE.

A NEW TIME SWITCH.

Fig. 12 depicts a time switch just placed on the market by J. Jones & Son, of New York, in which the mechanism is entirely mechanical, the current traversing the switch only. In the upper left-hand corner is an eight-day clock movement having two dials, one above the other, the under one of which is calibrated so that every 15° represents an hour. A pin on the front dial engages the front lever which releases a clutch, allowing the switch axle to turn through an angle of 90° and close the circuit. A similar arrangement on the back dial engages the back lever which releases a second clutch, allowing the switch blades to rotate 90° more, and open the circuit. As both dials revolve at the same rate of time all that is necessary to do to set the switch is to place the pin on the front dial so many hours in advance of the pin on the

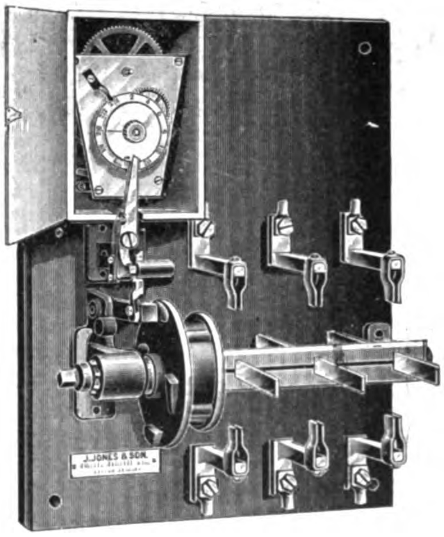


FIG. 12.—TIME SWITCH.

second dial as one wishes to keep the circuit closed. The cylinder to the left of the switch contains a strong spring, which is wound by a key and which furnishes the power to rotate the switch axle. The switch will operate on as heavy a current as 200 amperes.

CREST MOTOR TRICYCLE.

Since the introduction of the automobile quite a number of the progressive electric-light superintendents have recognized the importance of this type of vehicle in connection with the electric-light and electric-railroad industry for the purpose of patrolling overhead circuits, and also for making quick repairs in case of accident. The gasoline motor tricycle illustrated by Fig. 13 is a most convenient machine for this purpose, as it is started instantly by a few turns of the pedal, and a high rate of speed can be maintained. Any speed up to twenty or thirty miles an hour, it is claimed, can be maintained for any distance. The tricycle can be rigged so as to carry a ladder, if necessary, and also coils of wire, or tools for repairs. This machine is built by the Crest Manufacturing Company, Cambridgeport, Mass. It is equipped with an air-cooled 3-h.p. Crest motor, hung on the rear of the frame; the rear axle is provided with differential gear, preventing the grinding of one tire when turning a curve.

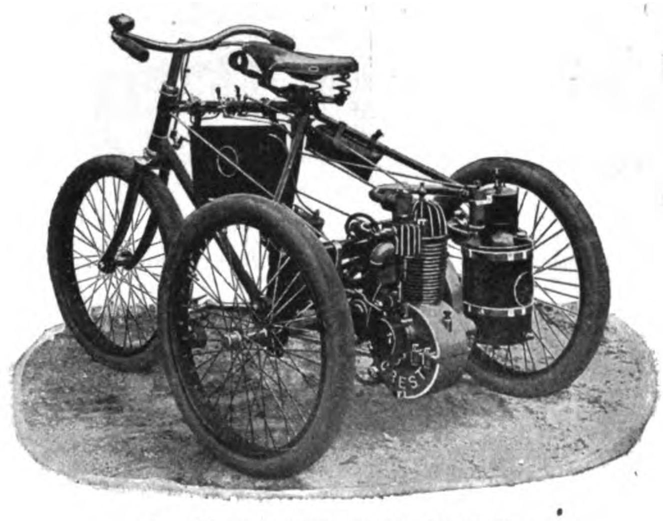


FIG. 13.—GASOLINE MOTOR TRICYCLE.

A NEW MAIN-LINE TELEGRAPH SOUNDER.

Fig. 14 represents a new main-line telegraph outfit comprising a high-resistance sounder and the regular form of steel lever key mounted on a single base which is being manufactured by Foote, Pierson & Co., of New York. The feature of the sounder is the means provided for adjusting the distance between the magnet poles and the armature. A close inspection of the illustration will show that the armature is screwed to a short brass strip which is separate from the sounder lever proper. This strip is pivoted at its rear end to the sounder lever, and the thumb-screw shown immediately back of the armature screw enables the operator to adjust the armature back and forth without altering the adjustment of the sounder lever. The convenience of this arrangement will be obvious to any telegraph operator, although it may not be so to others. Once having adjusted the play of the sounder lever to give the desired loudness of click it is unnecessary to change this adjustment in order to adjust the armature toward and away from the magnet cores; whereas, with the ordinary sounder any adjustment of the armature vitiates the adjustment of the lever play, rendering two adjustments necessary to accomplish a single purpose. With the sounder here shown only one thumb-screw has to be manipulated in order to adjust the distance between the magnet pole and the armature. The sounder coils are wound to 150 ohms resistance so as to work on main-line circuits without an intermediate relay.

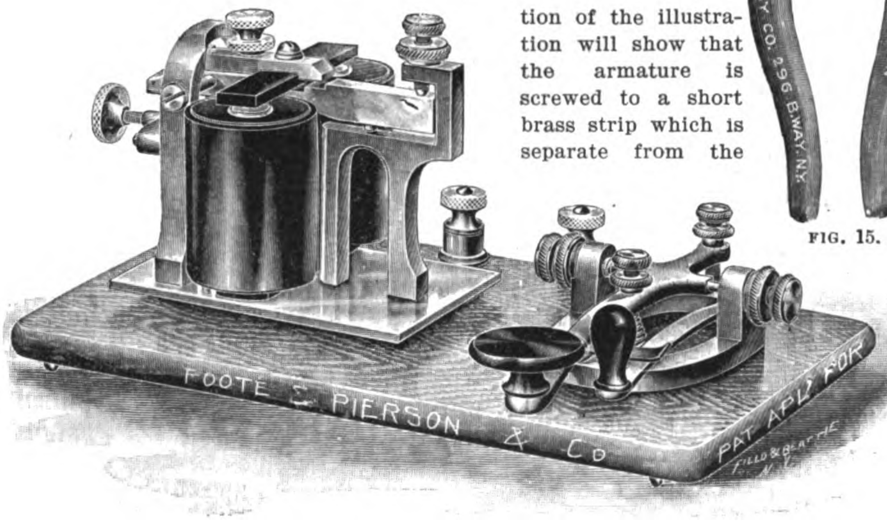


FIG. 14.—MAIN LINE TELEGRAPH SOUNDER.

INSULATED PLIERS.

The Smith & Hemenway Company, of New York, has brought out the insulated pliers illustrated by Fig. 15. The handles are covered with removable rubber shields, and all edges are rounded so that the pliers may be carried in the pocket without injury to the clothes. The advantage of this feature will be entirely obvious to anyone who has carried an ordinary pair of pliers. The tool is of the standard side-cutting type, made of the finest grade of Swedish tool steel.

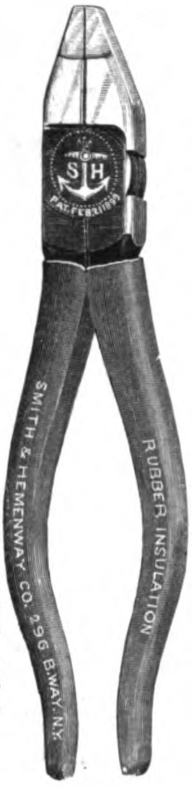

S H
SMITH & HEMENWAY CO. 296 B'WAY N.Y.
RUBBER INSULATION

FIG. 15.

LEGAL NOTES.

EICKEMEYER ARMATURE WINDING.—The suit of the General Electric Company against the Webster & Dudley Street Railway in the United States Circuit Court of Massachusetts to determine the validity of the Eickemeyer patent No. 377,996, covering the well-known Eickemeyer armature winding, has been decided in favor of the General Electric Company, the Court holding that claim 4 of the Eickemeyer patent was infringed by the defendant's armature construction. This claim reads: "In a dynamo-electric armature winding composed of detachable counterpart coils, each of which is placed in immediate contact with the periphery of the armature core at one side only, substantially as described."

RICE BRUSH-HOLDER.—The United States Circuit Court of New Jersey has rendered a decision sustaining patent No. 394,999, dated December 25, 1888, and issued to E. W. Rice, Jr., covering a brush-holder for carbon brushes, consisting of the usual box, a pivoted finger arranged to force the brush toward the commutator under the influence of a main spring and an intermediate auxiliary spring between the follower and the brush. The suit was brought against the Walker Company, and a perpetual injunction was issued restraining the company from the manufacture and sale of brush-holders of the construction indicated.

OBITUARY.

PROF. ELISHA GRAY.—The electrical fraternity was greatly shocked on January 21 to hear of the sudden death on the preceding night of Prof. Elisha Gray, the well-known electrical inventor. Prof. Gray's death, due to heart failure, occurred at Newtonville, Mass., whither he had gone for the purpose of perfecting a system of submarine signaling. He was born in Barnesville, Ohio, August 2, 1835, and became a carpenter's apprentice in his teens. At the age of 21 he entered Oberlin College, where he paid his expenses by doing carpenter work. Young Gray took the degrees of A. M. at Oberlin College and Ph. D. at Ripon College. His first invention of importance was a self-adjusting telegraph relay, which, however, never came into extended use because the self-adjusting feature was not sufficiently needed to justify its expense. The first invention to become commercially successful was a printing telegraph. He next produced the harmonic telegraph system, which indirectly led to his invention of the telephone. It is generally understood that Prof. Gray filed a caveat, which purported to describe a speaking telephone, on February 14, 1876, and that later on the same day Alex. Graham Bell filed his application for a patent. It is contended by Prof. Gray's friends that the priority which the Patent Office conceded to Prof. Bell's patent application over Prof. Gray's caveat application was due to the fact that Bell's application came in later than the caveat and was therefore taken off the filing hook for entry ahead of the latter; being entered first, it was given priority over Prof. Gray's application for caveat. Of Prof. Gray's inventions, the one which probably attracted the most attention was the telautograph, which was first publicly exhibited at the World's Fair in Chicago in 1893. During the past year or so Prof. Gray had devoted his time principally to the development of a system of submarine signaling, the object of which was to provide for the detection of sounds produced under water several miles away. This system was intended for the transmission of definite signals and also as a means for determining the proximity of submarine vessels. Mr. Gray was for a number of years connected with the Western Electric Manufacturing Company, which is now the Western Electric Company, and during this period he did considerable valuable work on instruments of a minor character, such as annunciators, magneto call boxes, etc. Prof. Gray leaves a widow, two daughters, and two sons to mourn his sudden demise.

PERSONALS.

MR. W. C. KERR, of Westinghouse, Church, Kerr & Co., has returned from a business trip to England.

MR. FRANK J. SPRAGUE has returned from an enjoyable trip abroad. Mr. Sprague was one of the speakers at a recent meeting of the British Institute of Electrical Engineers.

MR. BANCROFT GHERARDI, previously of the engineering staff of the New York Telephone Company, has been appointed chief engineer for the New York and New Jersey Telephone Company.

MR. G. W. HUBLEY, superintendent of the Louisville Electric Light Company, Louisville, Ky., has been appointed representative in Kentucky and Indiana for the Consolidated Telpherage Company.

MR. HOWARD L. DAVIS, recently of the testing department of the General Electric Company at Schenectady, has been appointed superintendent of the Hudson River Gas & Electric Company at Tarrytown, N. Y.

MR. H. P. BROUGHTON, who was for many years engaged in consulting engineering in St. Louis, and is well known throughout the west and southwest, has joined the staff of the Central Electric Company, Chicago.

MR. ROGER W. CONANT, for several years electrical engineer to the Boston Elevated Railway Company, has resigned that position to accept the managership of the New York office of the Gold Car Heating Company.

MR. P. V. VANDEVELDE, Corona, N. Y., who has for some time been interested in electrical matters, recently obtained a patent on an ingenious form of electric burglar-alarm which is considered by many to be superior to previous forms of alarms.

MR. GEO. F. LEMON has resigned the position of superintendent of motive power and electrical engineer of the South Covington & Cincinnati Street Railway Company. Mr. Lemon's plans for the future are not yet completely formulated.

MR. MAXWELL A. KILBERT, of the firm of Wendell & McDuffie, New York, has gone on an extended trip to Mexico for the purpose of closing some important contracts for material and apparatus for projected electric railways. Mr. Kilbert will be absent about three months.

MR. S. FISCHER MILLER, formerly with Milliken Brothers, manufacturers of structural iron, has been appointed manager of the contracting office of the American Bridge Company, vice Mr. Seymour N. Robinson, resigned, with headquarters in the St. Paul Building, New York City.

MR. HUGH H. HARRISON, formerly connected with J. G. White & Co., has joined Messrs. F. Battles and G. G. Heye in forming the firm of Battles, Heye & Harrison. The new firm will deal in municipal bonds and high-grade unlisted securities. Offices will be maintained in New York and Philadelphia.

MR. W. R. MASON, recently manager in St. Louis for the Siemens & Halske Company of America, has been appointed district manager for the Northern Electrical Manufacturing Company and the Stanley Electric Manufacturing Company, with headquarters at 1010 Laclede Building, St. Louis.

MR. ALEX. WYNESS, JR., superintendent of the Geneseeo Gas Light Company, Geneseeo, N. Y., has been elected secretary of the company. Mr. Wyness' election to this office is a well-merited recognition of valuable services which he has rendered the company in other directions besides the mere superintendence of plant operation.

MR. CHAS. H. SCHUM, who has been for the past four years associated with F. A. LaRoche & Co., resigned his position there to accept a similar one with the Bergmann Elektromotoren und Dynamo Werke, of Berlin, Germany. Mr. Schum is a graduate of Cornell University and has had valuable experience in dynamo and switchboard design. He sailed from New York for Germany on January 3.

OSTERBERG & SUTTON. — This well-known firm of consulting engineers dissolved partnership on January 1. Mr. Max Osterberg, formerly the senior member of the firm, will continue to devote his energies to consulting engineering and expert work, and Mr. Frank Sutton will also do electrical engineering work and prepare specifications for heating and ventilating plants, sprinkling, and fire protection systems.

MR. THOS. H. BIBBER and CHAS. E. BIBBER have severed their connection with the Bibber-White Company, of Boston, and will engage in business for themselves. Mr. Thos. Bibber has established an office at 37 Arch Street and will represent various manufacturers under the firm name of Thos. H. Bibber & Co. Mr. Chas. Bibber will engage in contract work in both the electrical light and railway branches; his office is also at 37 Arch Street.

MR. GEO. O. PROCTOR, of the Anchor Electric Company, Boston, who has been for two years the mayor of Somerville, Mass., was tendered a banquet at Young's Hotel, Boston, upon retiring from office recently. Very flattering references to Mr. Proctor's administration were made by those present, his conduct of the city's affairs being characterized as highly efficient, this efficiency being due to the sound business sagacity which has enabled him to make such a success of his private interests.

MR. SEYMOUR N. ROBINSON has resigned his position as New York manager for the American Bridge Company and become interested in a new organization known as the Berlin Construction Company, incorporated for the purpose of designing and erecting steel buildings, bridges, and doing general structural work. Mr. Robinson is treasurer of the new company and the other gentlemen associated with him in the organization were identified for many years with the management of the Berlin Iron Bridge Company before its absorption by the American Bridge Company.

TRADE PUBLICATIONS.

ELECTRO-MAGNETS.—The Varley Duplex Magnet Company, Jersey City, N. J.—A well-illustrated catalogue and price-list of Varley magnets, induction coils, gas-lighting spark coils and gas-engine igniters.

NOISELESS PINIONS.—The New Process Raw Hide Company, Syracuse, N. Y.—A vest-pocket folder setting forth the advantages of rawhide pinions, which are said to be noiseless, durable, cleanly and economical.

CALENDAR.—The American Electrical & Maintenance Company, New York.—A very ornate calendar gotten up in imitation of embossed bronze and bearing a handsome picture dating back in style to continental days.

SILICA GRAPHITE PAINT.—Joseph Dixon Crucible Company, Jersey City, N. J.—A folder pointing out the advantages of protective paint for steel smokestacks, boiler fronts and other metal surfaces subjected to unusual heat.

CALENDAR NOTE-BOOK.—John A. Roebling's Sons Company, New York.—A very convenient soft-leather backing accompanied by 12 sets of leaves, one set for each month of the year, adapted to be inserted in the leather backing.

CALENDAR.—Chas. Weslow, Harrison, N. J.—A small hanging calendar with a monthly-leaf date pad, and an illustration showing three forms of worn-out incandescent lamps, the object being to call attention to Mr. Weslow's business of renewing broken and defective lamps.

CALENDAR. — Chase-Shawmut Company, Boston.—A hanging calendar with the usual form of calendar block divided into monthly leaves and containing also a half-tone engraving showing the various types and sizes of fuse links, enclosed fuses, and electromagnets made by the Chase-Shawmut Company.

CALENDAR.—The H. C. Roberts Electric Supply Company, Philadelphia.—This is the usual monthly blotter calendar of the series which the Roberts Company is sending out. The blotter has on one end a picture of a handsome woman holding a cornucopia, and on the other end an illustration of an incandescent lamp.

STORAGE BATTERIES IN A RESIDENCE PLANT.—The Electric Storage Battery Company, Philadelphia.—This is circular No. 63, containing an illustrated description of an isolated electric lighting plant in a private residence, which includes an outfit of Chloride accumulators having a capacity of 1200 ampere-hours.

SELF-OILING ENGINES.—The Ball Engine Company, Erie, Pa.—A handsome catalogue of standard size illustrating and describing the Ball Engine Company's latest type of self-oiling horizontal engine in simple, tandem-compound, and cross-compound forms. The catalogue is of unusual interest to engine users and should find a place in every catalogue file.

EMERSON FAN MOTORS.—The Emerson Electric Manufacturing Company, St. Louis, Mo.—An extremely handsome catalogue containing illustrations, descriptions and price-lists of the Emerson line of alternating-current fan motors for 1901. The engravings are of the highest grade of half-tone work and the general execution of the book is a model of typographical excellence.

SERIES ALTERNATING-CURRENT ENCLOSED-ARC SYSTEM.—Western Electric Company.—This is Bulletin No. 7009, containing a description of the Western Electric Company's new system of control for series arc-lighting circuits supplied from constant - potential alternating - current mains. The book is fully illustrated with pictures of the apparatus and diagrams showing the various arrangements of circuits.

DYNAMOS AND MOTORS.—Bartz, Evans & Wygant, Hornellsville, N. Y.—Bulletins No. 1, 2, 3 and 4, in which are described the bipolar and multipolar dynamos and motors built by this firm. Bulletin No. 1 describes belt-driven multipolar generators; Bulletin No. 2 describes the same type of motors and includes the starting box; Bulletin No. 3 describes the firm's bipolar dynamos, which are built in sizes ranging from ½ to 2½ kilowatts; and Bulletin No. 4 describes the same type of motor.

SKEPTICISM.—Electric Appliance Company.—An attractive little pamphlet having for its object the dispelling of any skepticism which may exist regarding the performance of the Gutmann wattmeter, and containing a complete explanation of the construction of this meter and the principle on which it operates. The meter is of the induction type, and the Electric Appliance Company, which is selling agent for the meter, offers to send an instrument on trial to any responsible meter buyer.

I. T. E. CIRCUIT-BREAKERS.—The Cutter Company, Philadelphia.—This is an interesting publication prefaced by an explanation of the functions of a circuit-breaker and explaining the meaning of the symbols "I. T. E." which form part of the name of the company's instrument. The catalogue is divided into six sections printed on different colored papers. Part A describes circuit-breakers built to open the circuit under the influence of an overload; Part B describes instruments for opening circuits when the current supply has been shut off elsewhere; Part C describes and illustrates circuit-breakers for storage battery service to open the circuit when the charging e.m.f. falls below that of the battery; Part D relates to combined overload and no-voltage circuit-breakers; Part E describes circuit-breakers for storage battery use arranged to open by either overload or low voltage; and Part F is devoted to the "laminated edgewise" type of circuit-breaker for railway service.

BUSINESS NEWS.

WESTERN ELECTRIC COMPANY, Chicago, has received an order for two direct-current generators of 100 kilowatts each and one of 50-kw. output for the isolated plant in Willard's Hotel, Washington, D. C.

HENRY H. HUMPHREY, of St. Louis, Mo., has removed his engineering offices from the Century Building to suite 1305, Chemical Building, where he will have better facilities for taking care of his rapidly increasing consulting work.

THE HOMER COMMUTATOR COMPANY, Cleveland, Ohio, has moved into its new factory at the corner of Mason and Wilson Streets, which is fully equipped for the production of high-grade commutators and the re-filling of commutator shells.

CATALOGUES WANTED. McKenna Bros. Brass Company, of Pittsburgh, having arranged to establish a switchboard department, as previously announced in these columns, wishes catalogues and discount sheets from manufacturers of switchboard material and appliances.

O. C. WHITE COMPANY, Worcester, Mass., has added to its well-known line of incandescent lamp fixtures a new line of high-grade fixtures designed especially for office, bank and library use. It is the company's aim to turn out a complete assortment of adjustable fixtures for all classes of service.

THE C & C ELECTRIC COMPANY, New York, reports that it is now busier than ever before during its entire history. New orders are pouring in, not only from all parts of this country, but from abroad. For over a year the company's works at Garwood have been running every night with a constantly increasing force, and the large force now employed is pressed to its utmost ability to take care of orders.

AMERICAN ELECTRIC COMPANY, Detroit, Mich., has been dissolved, Mr. W. J. Hartwig, the senior partner in the old concern, having purchased the entire business. Mr. Hartwig will continue the manufacture of the Anthony boring tool, as well as the electrical supply business previously carried on by the American Electric Company. The business will be continued at the old address, 256 Randolph Street.

THE WARREN COMPANY, Chicago, Ill., is rejoicing over the continued receipt of extremely complimentary letters regarding its liquid pulley cover. One user writes to say that the Warren pulley cover is one of the best things ever invented, and that it has saved that consumer at least $150 in belting alone, and enabled it to carry the holiday load on belts that ordinarily would barely carry the regular load.

ABENDROTH & ROOT MANUFACTURING COMPANY, of New York, at its annual meeting, held recently, elected the following officers: Linus G. Read, president; H. C. Kelley, vice-president; F. W. P. Brunig, secretary and treasurer. This completes the reorganization instituted a year ago, and carries with it an association both of thorough factory and engineering equipment and gives the company a sales department which is fully abreast of twentieth-century methods.

THE FILER & STOWELL COMPANY, Wilwaukee, Wis., builder of high-grade steam engines, recently shipped the largest cross-compound engine ever built at its works. The cylinders of the engine were 40 and 76 ins. in diameter respectively by 60 ins. stroke, and the complete engine weighed about 800,000 lbs. The company recently booked an order for a still larger cross-compound engine which will have cylinders 44 and 82 ins. in diameter by 60 ins. stroke.

SPRAGUE ELECTRIC COMPANY, in order to facilitate the handling of its constantly increasing business in the south, has opened a branch office in the Guardian Trust Building, Baltimore, in charge of Mr. W. H. A. Davidson, who was previously connected with the New York office. The establishment of the Baltimore office will enable the company to keep in closer touch with the large amount of government work constantly being done, as well as to handle more conveniently the growing southern business.

THE HOPPES MANUFACTURING COMPANY, Springfield, Ohio, calls attention to the fact that the Brooklyn Electric Illuminating Company's plant, which was described in the January number, is equipped with three Hoppes feed-water purifiers of 1000-h.p. capacity each, which fact was not pointed out in the article. The Hoppes Company also states that the Brooklyn Company "made the mistake of not putting in Hoppes purifiers at the start, but has added them since." The failure to mention the purifiers in the article referred to was, of course, an oversight on the part of the writer of the article.

RICHMONDT ELECTRIC WIRE CONDUIT COMPANY, Milwaukee, Wis., desires to call the attention of conduit users to the fact that the Richmondt galvanized conduit pipe besides being reamed and enameled on the interior is supplied with clean threads which are fully galvanized. In the case of ordinary galvanized pipe the threads are cut after the tubing has been galvanized, which is said to leave each joint unprotected against rust. The company also states that the Richmondt conduit is the only one which can be permanently and thoroughly grounded. The fact that the threads are protected from rust insures a continuous and permanent electrical connection between adjoining lengths of pipe.

TEST OF LE VALLEY VITAE CARBON BRUSHES.—An important test of carbon brushes on railway motors was made some time ago by the Quebec Railway Light & Power Company, which resulted as below:

	Ordinary Brushes.	Le Valley Brushes.
Wear on commutator per 1000 miles	.054	.01
Life of commutator, miles	82,600	278,800
Rel. efficiency on com.	29%	100%
Wear on brushes, 1000 miles	.22	.06
Life of brush, miles	3,680	13,900
Rel. efficiency of brushes	28%	100%

The "Life of Commutator" was limited to a wear of 1½ ins. off the diameter, and "Life of Brush" means the number of miles necessary to wear the brush away ¾ in. Three grades of ordinary carbon brushes were included in the test; the figures given above are the averages shown by these three. The Quebec company stated that during the test the ordinary brushes cut the commutators badly under heavy currents, while the Le Valley Vitae brushes did not cut at all.

CROUSE-HINDS ELECTRIC COMPANY, Syracuse, N. Y., is constantly receiving strong testimonials as to the merit of its switches and switchboard work. Among a recent batch of letters was an extremely

A COMMUTATOR NECESSITY.

For Sale by all Supply Houses.

Upon receipt of this coupon we will send FREE, sample stick.

Name..............................

Address..............................

A. E.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.

50c. per Stick. $5.00 per Dozen.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO.

complimentary one from the Elmira Municipal Improvement Company, Elmira, N. Y., in which the statements were made that the work put out by the Crouse-Hinds Company was of the very highest class possible, that the care and attention which the company showed to every detail was highly appreciated, and that there was not a single instance in which the slightest error was made in following out the Elmira Company's specifications, which is saying a good deal, as that company has had a great deal of work done during the past year.

ALBANUS L. SMITH & CO., Philadelphia, proprietors of the United Flexible Metallic Tubing Company, Ltd., call attention to the fact that the flexible metallic tubing manufactured at their works forms a reliable and indestructible substitute for rubber hose, being capable of carrying steam at all pressures, as well as oils, gas, compressed air, and other fluids. The tubing is said to be absolutely unaffected by either heat or cold and to remain flexible at all temperatures. It does not kink or crush, and consequently the cross-sectional area is always the same. Owing to recent improvements in the manufacture of this tubing it is now possible to supply it in almost every size up to 8 ins. in diameter. Special grades of the flexible tubing are made for extremely high pressures up to 2000 lbs. per square inch.

Northwestern Convention Notes.

THE CHICAGO MICA COMPANY, of Valparaiso, Ind., was represented by Mr. Charles W. Cobb.

MR. CHARLES E. COLEMAN, Chicago manager of Munsell & Company, New York, attended the Convention.

MR. GEORGE S. WHYTE took good care of the friends of the Macomber & Whyte Rope Company, of Chicago, Ill.

THE AMERICAN ELECTRICAL WORKS, of Providence, R. I., was represented by its Western manager, Mr. F. E. Donohoe.

JULIUS ANDRAE & SONS COMPANY, of Milwaukee, Wis., had an exhibit of telephones and other electrical specialties.

THE NATIONAL CARBON COMPANY, of Cleveland, sent its Chicago representative, Mr. Richard O'Connor, to the Convention.

JAMES McCREA & CO., of Chicago, manufacturers of steam joint clamps and boring tools, were ably represented by Mr. M. B. Skinner.

MR. J. G. POMEROY, Western representative of the Adams-Bagnall Electric Company, of Cleveland, Ohio, was a visitor at the Convention.

MR. M. B. KITT, representing the John A. Roebling's Sons Company, of Trenton, N. J., looked after the friends of this company in the West.

MR. JAMES W. HARKINS hospitably entertained the friends of the Dearborn Drug & Chemical Company of Chicago in room 81 of the Pfister.

THE AMERICAN STEEL & WIRE COMPANY, Chicago, sent the manager of its electrical department, Mr. E. J. Pietzeker, to the Convention.

MR. CHARLES F. HART, Western representative of the Skinner Engine Company, of Erie, Pa., attended the Convention in the interests of his company.

THE NORTHERN ELECTRICAL MANUFACTURING COMPANY, of Madison, Wis., had its interests looked after by Mr. D. E. Goe and Mr. F. H. Ford.

THE RICHMONDT CONDUIT COMPANY, of Milwaukee, had an interesting and unique exhibit of its conduits in charge of Mr. C. D. Richmondt.

MR. JAMES WOLFF, the popular Western representative of the New York Insulated Wire Company, was very much in evidence among his friends at the Convention.

THE AMERICAN CIRCULAR LOOM COMPANY, of Chelsea, Mass., was represented by Mr. H. B. Kirkland of New York, and Mr. Thomas G. Greier of Chicago.

THE MANHATTAN GENERAL CONSTRUCTION COMPANY, New York, had the interests of its well-known Manhattan arc lamp ably taken care of by Mr. F. L. Merrill, of its Chicago office.

MILWAUKEE ELECTRIC COMPANY, of Milwaukee, Wis., had three types of motors on exhibition, which attracted much attention from central station men. The company was represented by Mr. Walter Cary.

THE O. C. LITTLE PULLEY COATING COMPANY, of Menasha, Wis., exhibited a machine demonstrating the efficiency of its pulley coating in transmitting power. Mr. O. C. Little represented the company.

MR. A. LOUIS KUEHMSTED, treasurer and general manager of the Gregory Electric Company of Chicago, was present at the Convention and took good care of the many friends and customers of this company.

THE BRYAN-MARSH COMPANY, New York, was represented by its president, Mr. Converse D. Marsh of New York, and its Western representatives, Messrs. Leroy P. Sawyer, George C. Keech and Guy V. Williams.

THE WESTERN ELECTRIC COMPANY, of Chicago, had an extensive exhibit of its alternating and direct-current arc lamps and also showed some of its ceiling and desk fans, as well as several other types of apparatus.

THE COLUMBIA INCANDESCENT LAMP COMPANY'S interests were looked after by Mr. James B. Coale of Minneapolis, Minn., who represents the sales department of this company in the Northwest.

THE WARREN ELECTRIC & SPECIALTY COMPANY, of Warren, Ohio, exhibited through the Illinois Electric Company a line of its Peerless fan motors, transformers and lamps. Messrs. L. K. Cushing and C. W. Bacon had charge of this exhibit.

THE BARTH MANUFACTURING COMPANY, of Milwaukee, had an interesting exhibit of its electric passenger and freight elevator controller. The secretary of the company, Mr. Louis A. Riebs, explained the operation of the machine to all those present.

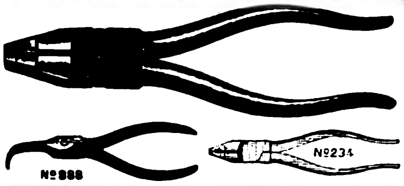
MR. F. R. BACON, president, and Mr. J. G. Hickcox, secretary of the Cutler-Hammer Manufacturing Company, Milwaukee, attended the Convention and made many new

289 MILES OF BEAUTIFUL AND HISTORIC SCENERY.

The Nashville, Chattanooga & St. Louis Railway offers to the tourist and pleasure-seeker one of the prettiest routes between the North and the South. Its through trains pass at the foot of grand old Lookout Mountain and through the famous battlefields of the Civil War between Nashville and Atlanta. They are equipped with the latest style modern day coaches and Pullman palace sleeping cars and are vestibuled from end to end. If you are going to Florida this winter consult the time-tables of the N., C. & St. L. before deciding upon your route. H. F. Smith, Traffic Manager, Nashville, Tenn.; W. L. Danley, General Passenger Agent.

Telephone Service
Puts the
Whole Organization
of a
Great City
At Your Fingers' Ends
Day and Night and
In All Weathers.
Rates in Manhattan from
$5.00 a Month.
One year contracts. Monthly payments.
NEW YORK TELEPHONE CO.
111 West 38th St. 15 Dey Street.

BIG STICK, 35 CENTS.
Sample Free.
SOUTHWORTH & HARE,
Indianapolis, Ind.



FINE AMERICAN TOOLS.
Largest manufacturers of Nippers and Plyers in the world. Our motto: THE BEST. See them in the GREEN BOOK.
SMITH & HEMENWAY CO.,
UTICA DROP FORGE & TOOL CO.,
296 BROADWAY, NEW YORK

A WONDERFUL ALL METAL RECEIVER.
NEEDS NO ADJUSTING. STRONGEST IN THE WORLD.
ERICSSON
SWEDISH
BI-POLAR
RECEIVER
4½ lbs
4½ lbs
IT IS THE BEST. WHY NOT HAVE IT?
ERICSSON TELEPHONE CO. 296 Broadway N.Y.

PLATINUM
In Sheet or Wire, any Degree of Hardness.
FOR ALL PURPOSES.
BAKER & CO.,
NEWARK, N. J.
New York Office, 120 Liberty Street.

friends for the well-known line of rheostats and motor starters manufactured by their company.

THE WARREN ELECTRIC MANUFACTURING COMPANY, of Sandusky, O., and the TRIUMPH ELECTRIC COMPANY, of Cincinnati, O., had their interests looked after at the Convention by Mr. B. F. Stewart, of J. Holt Gates & Co., the Chicago agents for these companies.

THE HART MANUFACTURING COMPANY, the well known switch manufacturers of Hartford, Conn., and the BOSSERT ELECTRIC CONSTRUCTION COMPANY, manufacturers of outlet and junction boxes, at Utica, N. Y., were ably represented by Mr. W. P. Crockett, their Western representative.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, of St. Louis, Mo., was represented by its Western manager, Mr. George B. Foster, assisted by Mr. J. F. Begoll. They exhibited to many interested spectators one of the company's many new styles of transformers which excited much favorable comment.

THE HART & HEGEMAN MANUFACTURING COMPANY, of Hartford, Conn., well known to the trade as the manufacturer of "Hart" and "H. & H." switches, was represented at the Convention by Mr. George S. Searing, of Chicago, who also looked after the interests of the Peru Electric Manufacturing Company, of Peru, Indiana.

THE BROWNING MANUFACTURING COMPANY, of Milwaukee, had one of the most interesting and complete exhibits at the Convention. Wires were run into its room and motors connected up in order to demonstrate to visitors the smooth and noiseless operation of the machines, ranging from small dental motors to 3½ h.p. motors.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, sent a full delegation to the Convention headed by its president, Mr. W. W. Low. Others in the party were Mr. B. B. Downs, Mr. W. P. Upham and Mr. S. A. Rall. Among other things it exhibited the Adams-Bagnall arc lamp and the Gutmann wattmeters for which it is sales agent in the West.

THE SAWYER-MAN ELECTRIC COMPANY exhibited some of its incandescent lamps, and by means of a photometer outfit gave convincing proof of their efficiency. These lamps were used in the sign of the Westinghouse Electric Company. The exhibit was in charge of Mr. C. A. Ross, manager of the Chicago office, and Mr. R. S. Mueller.

THE SHELBY ELECTRIC COMPANY, Shelby, Ohio, exhibited various types of its incandescent lamps, and demonstrated by means of a Queen photometer to many interested visitors that the Shelby lamps give an unusual amount of light through the tip. The company was represented by Mr. O. D. Pierce, of Shelby, Mr. W. S. Reynolds, of Detroit, Mich., and Mr. C. A. Meade, of Chicago.

M. B. AUSTIN & CO., of Chicago, had an exhibition in their rooms of the Belden arc lamp manufactured by the Belden-Larwill Electric & Manufacturing Company of Fort Wayne, Ind., and also showed several other specialties, for which they are sales agents in the West. They were represented by Messrs. M. B. Austin, A. H. Friend, C. N. Jackson, C. A. Robinson, A. Meinema and W. A. Browne.

THE ALDEN ELECTRIC COMPANY, of Chicago, was represented by Mr. C. A. Kuhlman. Mr. Fred H. Alden, president of the company, and Mr. J. Geiserowich, secretary and treasurer, were unable to be present. They are exceedingly busy at present moving the factory of the Illinois Insulated Wire Company from Sycamore, Ill., to Chicago. Their new factory will be in operation in a very short time.

THE CHRISTENSEN ENGINEERING COMPANY, of Milwaukee, sent a handsomely engraved invitation to the Convention delegates to visit its new offices and works. Many availed themselves of this opportunity. The company was represented at the Convention by its sales manager, Mr. George J. Caldwell, who received many congratulations from his friends on his recent appointment to this position.

THE GENERAL INCANDESCENT ARC LIGHT COMPANY, PARAGON FAN & MOTOR COMPANY, and CHICAGO RHEOSTAT COMPANY, New York, all had their headquarters in room 8 at the Pfister. Numbers of central station men could be found there at all times examining the arc and incandescent lamps, Wright discount meters, switches and various other specialties exhibited by these companies. They were ably represented by Mr. Francis Raymond, Western sales manager, and Mr. Thomas James of the Milwaukee office of the General Incandescent Arc Light Company.

MR. E. F. KIRKPATRICK, well known as "Kirk" in electrical circles, commenced the new century as Western representative of the McRoy Clay Company of New York. His offices are located in the Chamber of Commerce Building, Chicago. Mr. Kirkpatrick entertained many friends of the McRoy Company at his headquarters at the Convention and received numerous congratulations on his appointment. He will hereafter take charge of the entire business of the McRoy Company in the West. With fifteen years' experience in the electrical business Mr. Kirkpatrick has made a host of friends, all of whom wish him success in his new enterprise.

THE FORT WAYNE ELECTRIC WORKS, of Fort Wayne, Ind., was, as usual, represented by its well-known salesmen, Messrs. Willard Knight and Frank McMaster. Mr. King, chief of the meter department, was also on hand to explain the details of the type "K" meter, which attracted a great deal of attention, owing to its many practical features, such as the interchangeability of all parts. The entirely new features of adjustment in this meter caused a great deal of interest. Mr. Edward A. Wagner was also on hand to explain the leading features of the new "Type A" transformers, which have also some entirely new and useful features. A 5-h.p. Wood automatic starting box, with overload and underload release, was also exhibited, and elicited much merited commendation.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY presented a detail exhibit of apparatus, consisting of a Westinghouse wattmeter, which was shown in operation in connection with suitable switchboard instruments, particular attention being called to the company's new line of long-scale indicating instruments. It also exhibited its types of lightning arresters, fan motors, cut-outs, etc. A prominent feature of the exhibit was the new "O.D." type transformer, which represents the most modern practice in construction, and was briefly described in this paper a few months ago. A large electric sign, suspended across the west end of the hall, bore the name of Westinghouse. The officials representing the company during the Convention were W. R. Pinckard, C. C. Burton, T. P. Gaylord, W. S. Rugg and Ervin Dryer. Mr. Arthur Hartwell, manager of the Chicago office, was expected to be present, but was detained by urgent business matters which could not be deferred.

THE GENERAL ELECTRIC COMPANY was efficiently represented at the Convention by Messrs. B. E. Sunny, general Western manager; F. N. Boyer, manager supply department, Chicago office; L. G. Crawford, J. Scribner, S. F. Dibble and Thomas Ferris, of Milwaukee; F. G. Vaughn and P. D. Wagoner, of Schenectady. The General Electric Company's exhibit was unusually interesting to the electrical fraternity, and comprised many new and interesting pieces of apparatus. Probably the most interesting new device exhibited at the Convention was the apparatus for controlling series incandescent lamps for street lighting, which was referred to in Mr. Wagoner's paper read before the convention. This system is similar in principle to the well-known constant-current transformer system for arc lighting, but slightly different in practical application. These regulators have been in use for about a year, but have not been pushed, as it was the desire of the General Electric Company to obtain results of practical operation before pushing the sale of these coils.

SOLID TRAINS TO NORTHERN MICHIGAN.

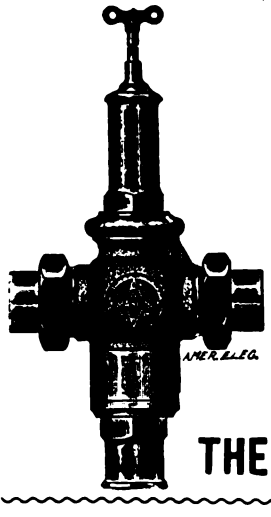
The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

The TRACY OIL FILTER

Perfect Filtration fully guaranteed. Will positively save 75 per cent. of your oil bills.
Send for circular.

Phœnix Automatic Filter Co.,
Racine, Wis., U. S. A.



THE MASON

Reducing Valves

ARE THE WORLD'S STANDARD VALVES

For automatically reducing and absolutely maintaining an even steam or air pressure.

They are adapted for every need and guaranteed to work perfectly in every instance.

WRITE FOR FULL INFORMATION AND SPLENDID REFERENCES.

THE MASON REGULATOR CO., Boston, MASS., U. S. A.

American Electrician.

Vol. XIII. New York, March, 1901. No. 3.

A NOTABLE INDEPENDENT TELEPHONE EXCHANGE.

THE LAMP SIGNAL BRANCH EXCHANGE AT EAST CLEVELAND, OHIO.

BY GEORGE L. BURLINGAME.

THE new branch exchange of the Cuyahoga Telephone Company, which was recently installed as a part of its comprehensive system in Cleveland, Ohio, embodies all of the latest features of the most modern lamp-signal central energy equipments. This branch exchange is known as the "East Office," and is located on Lake Front Avenue in the extreme eastern part of the city, about eight miles from the main exchange. The building, shown in the initial engraving, was erected by the telephone company and is a two-story structure of complete fire-proof construction. The walls are made of pressed brick with gray stone trimmings and the whole is very artistic in design. The operating room is on the first floor and the walls and ceilings are very attractively decorated. This room was designed to accommodate a switchboard of about 2000 lines capacity, disposed in U-shape around three sides of the room.

The distributing room is located in the basement directly under the exchange room, and is large enough to allow the installation of two relay frames, with a capacity of 2160 line and cut-off relays, two 1200-line distributing frames and two terminal frames for twenty-four 100-pair Cook terminal heads. But one frame of each type has been installed. These are securely fastened to the brick partitions and tied together at the top with a cable rack or iron running box in which all of the cables to and from these frames are carried. On one side of the distributing room the power plant and the hot-water furnace for heating the building are located, while the other side has been attractively fitted up as a retiring and locker room. A kitchen and pantry in which there are a gas range and a porcelain sink adjoins the distributing room. These rooms contain many conveniences for the operators when not on duty, such as sofas, rockers, etc., while on the table may be found the latest magazines and papers. This feature is characteristic of the policy of the Cuyahoga Telephone Company, which has always shown the greatest consideration for the comfort of the operating force.

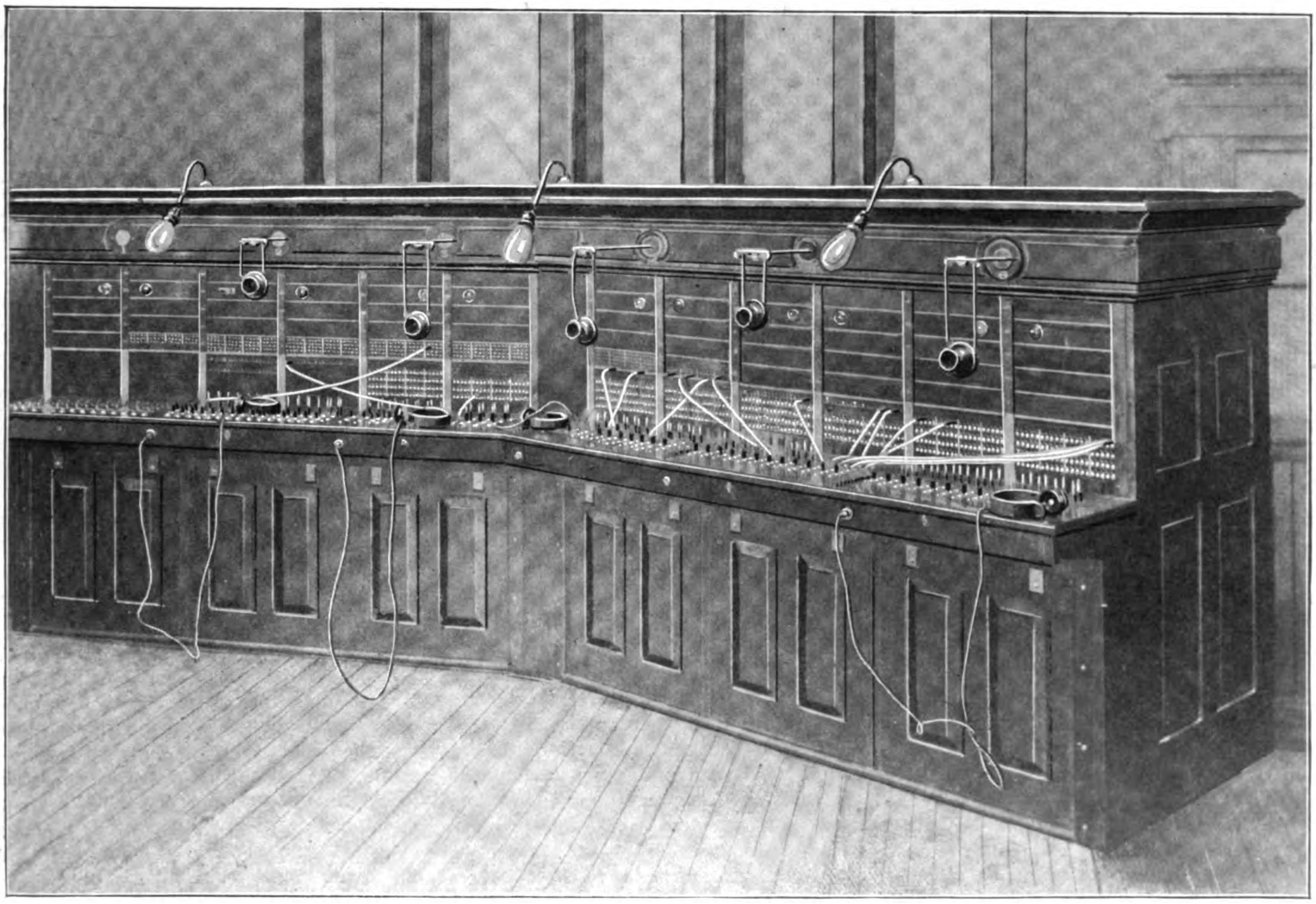


FIG. 1.—TWO SIX-PANEL, THREE-OPERATOR SECTIONS WITH LAMP SIGNALS.

The underground cables leave the manhole about 150 feet from the exchange and enter the basement in a specially designed cement duct about 3 ft. wide and 2 ft. deep, which is covered with iron traps so arranged with flush rings that they can be easily taken up. From this they are led directly to the 100-pair Cook heads, which are mounted on the terminal frame, as shown in the background of Fig. 2. Switchboard cables lead from these heads directly to the line terminals on the main distributing board, shown in the foreground of the same engraving. These cables are made of 102 pairs of No. 24 tinned copper wire, insulated with two windings of silk and one of cotton, the whole being wrapped with several layers of paper and sheathed in a braided covering. These were all treated previously with hot beeswax which penetrates to the paper, leaving a dry core and thus providing a perfectly moisture-proof insulation. All of the cable used within the building was made on this plan by the Kellogg Switchboard & Supply Company, Chicago, who also furnished the telephonic apparatus throughout. The underground cables were made by the Standard Underground Cable Company, Pittsburg.

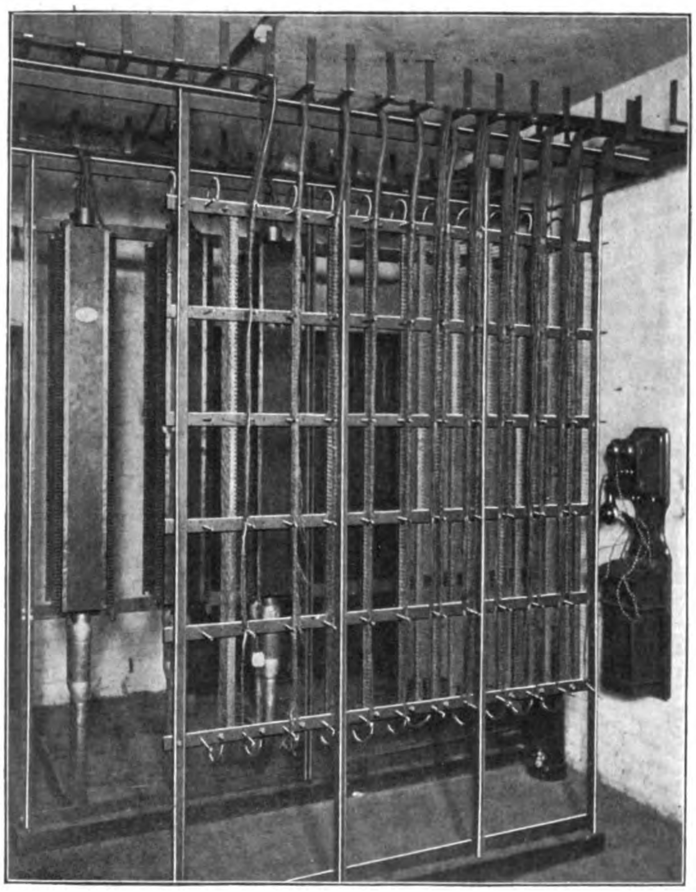


FIG. 2.—REAR VIEW OF TERMINAL FRAME.

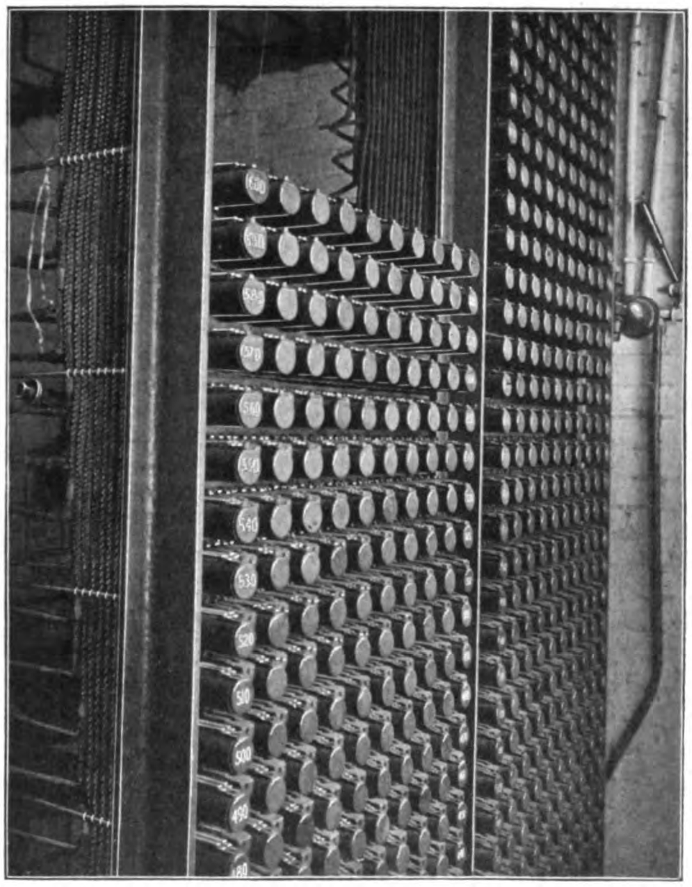


FIG. 3.—FRONT VIEW OF RELAY FRAME.

After being cross-connected or "jumpered" with No. 24 silk and cotton jumper wire from the line or terminal side to the relay side of the main distributing frame, the lines are carried in 21-pair cables on the cable rack at the top, to the line and cut-off relays at the relay frame as shown in Figs. 3 and 4. These relays are mounted twenty of each per strip, there being space on the relay frame for eighteen such strips or 720 relays in each of the three panels or banks. The function of the line relay is to light the line lamp or signal on the switchboard when a subscriber lifts his telephone from the hook and the cut-off relay "cuts off" this line relay when the operator inserts the plug in answering the call, thereby putting out or restoring the line signal.

After passing through these relays the lines are carried by means of 63-wire cable through a running box to terminals on the connecting rack located on the rear of the legs of the switchboard, and are thence carried in 21-pair cables through a box panel at the left end of the first section to the multiple jacks appearing in each section. From these same terminals, but on the inside or front of the connecting rack, 63-wire cables are carried to the answering jacks and line lamps.

Two six-panel, three-operator sections have been installed thus far; these are shown by Fig. 1. The framework is of angle iron construction, rigidly braced and covered with mouldings and panels of mahogany. The line lamp signals are mounted 20 per strip on ½-in. centers, the strips of lamps and answering jacks appearing alternately, as shown just above the key-shelves in Fig. 1.

The first operator's position is not equipped. The second is used as an incoming trunk position. The trunk lines between this office and the 9600-line, 4-division Kellogg board (which was installed during the past two years and is located at the main office) end at this position in single cords. The method of operating these lines will be mentioned later. The third or last position of this section and the middle operator's position on the second section have each answering jacks and line lamp signals for 140 lines, while the first and last positions on the second section are equipped each for 160 lines, making a total of 600 subscriber's lines. Each subscriber's operator's position is equipped with twelve cord circuits, each consisting of a combined ringing and listening key having German silver springs, with contacts of 98 per cent pure platinum, two cords and plugs, each cord having its own supervisory lamp which is controlled by individual dustproof tubular supervisory relays, located in a covered box on the rear of the legs of the section above the connecting rack. This box contains the condensers, two of which are associated with each cord circuit.

The operator's equipment consists of a transmitter arm and solid back transmitter, suspended on two green silk cords, so arranged that the slack in these is automatically taken up as the transmitter is raised or lowered, together with a head telephone and green silk cord with plug attached and a head telephone jack which is located in the front of the key-shelf.

The method of operating is as follows: The subscriber desiring a connection lifts his receiver from the hook. This action operates the line relay above mentioned and causes the line lamp or signal to light, thereby notifying the operator of the call. In conjunction with all of the line signals at each operator's position, there is placed a common relay, known as a "line pilot relay," which is so wired that when any one of the line lamps is lighted the relay operates to light a line pilot lamp having a white jewel or lens, located in one of the blank multiple spaces, and also operates the buzzer located in the box panel. The buzzer is used especially at night, when but few operators are at work, to attract attention to the fact that there is a call, and the line pilot lamp shows at a glance at which position it is. The supervisory or disconnect signals at each position are also provided with a relay of the same description which lights a lamp having a red lens.

As soon as a call comes in, the operator inserts in the corresponding answering jack one of the plugs of any pair of the twelve cord circuits which which she is provided, at the same time cutting in the corresponding listening key. The supervisory lamp associated with this cord and plug does not light, the receiver on the line plugged into being off the hook. As soon as the operator gets the number required by the calling subscriber, if it is for a similar line at the East Office, she picks up the other plug of the pair and with the listening key still cut in, tests the desired line by touching the tip end of the plug to the brass shell of the multiple jack. If the line is being used by some other operator she receives a click in her head telephone, then she immediately tells the subscriber that the line is busy. If she receives no click, she inserts the plug and rings up the party called for by simply pressing forward the cam of the listening key above mentioned. When she inserts the second plug the corresponding supervisory lamp at once lights up, denoting that the receiver is on the hook, and when the called subscriber answers, this lamp immediately goes out. As soon as the two subscribers finish talking and hang up the receivers, the two lamps light up again, which is the signal for the operator to disconnect; this operation puts out both lamps.

In case a connection has been established and one of the parties desires to make another call immediately, he can attract the attention of the operator by simply moving the receiver hook up and down a few times. This will flash the supervisory lamp and the operator will cut in on the line and get the desired number and proceed as before.

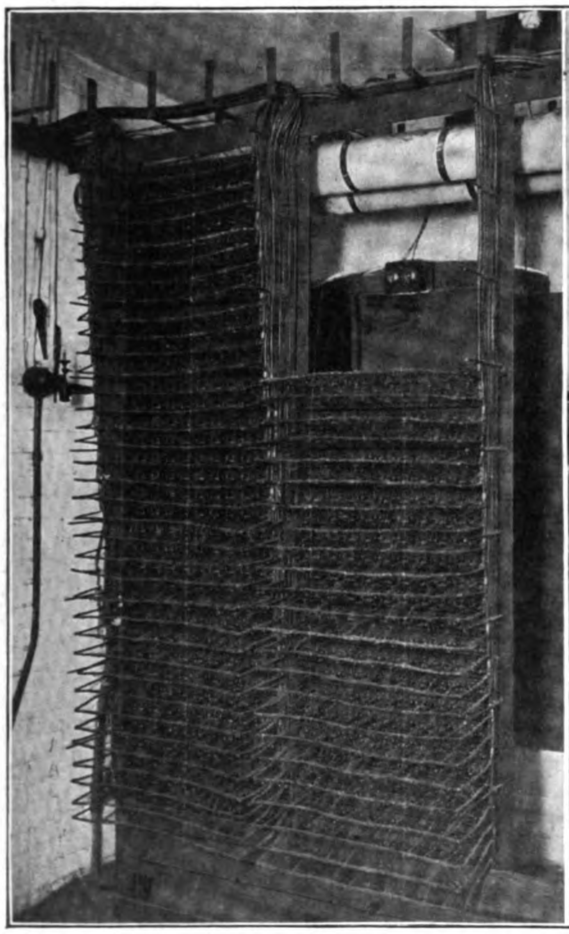


FIG. 4.—REAR VIEW OF RELAY FRAME.

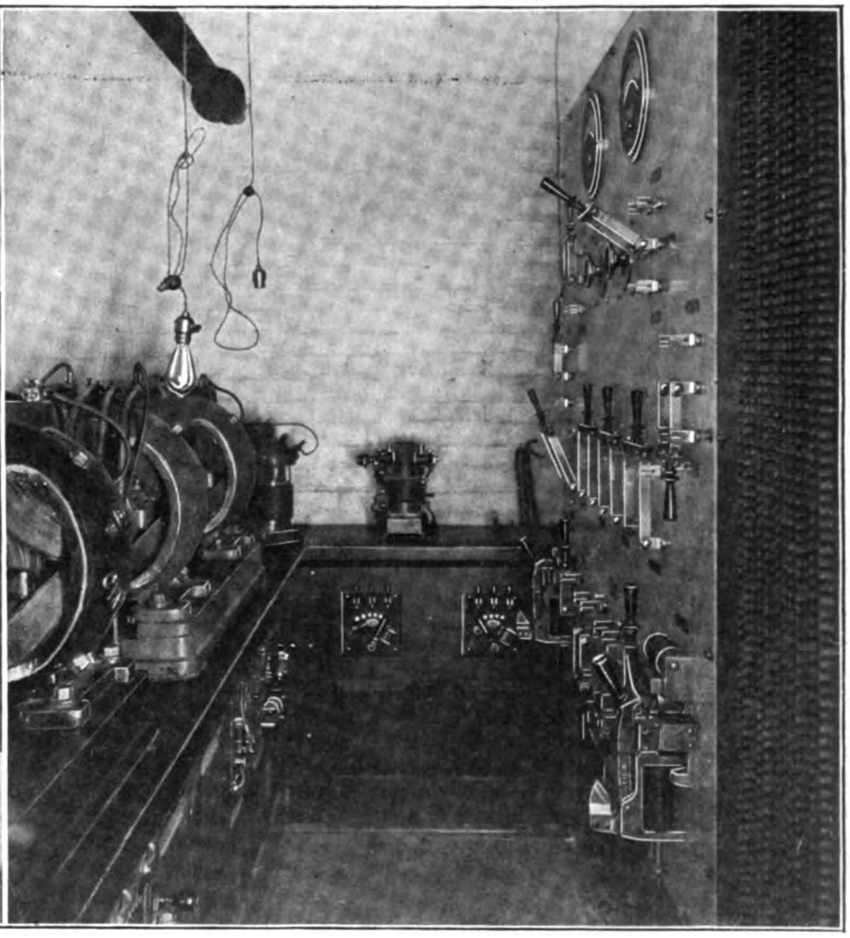


FIG. 5.—VIEW OF POWER EQUIPMENT.

It will be seen that by this method the operator has complete control of the connection and knows exactly whether the parties have answered or are still conversing without the necessity of listening in on the line, and this enables her to handle more lines than she could with the old clearing-out drop system.

Where a subscriber is wanted whose line ends on one of the four divisions in the main office, the operator tests in the usual manner and, if not busy, plugs into one of the forty outgoing trunk lines, which are multipled in the third and fourth panels of each section and which lead to the incoming trunk positions at the main office. By means of an order-wire key which goes direct to the operator's head 'phone at the division wanted in the main office, she tells that operator the connection, and the main office operator designates the trunk. The act of plugging into the designated trunk by the main office operator signals the East Office operator, when the latter rings up the main office subscriber called for in the same manner as if the connection were between two lines in East Office. When the main office subscriber hangs up his receiver after completing the conversation, the corresponding supervisory lamp is lighted at East Office, and when the East Office operator receives both disconnect signals, she pulls down the connection, which action lights the disconnect lamp at the main office incoming trunk position and this operator pulls down her connection. Calls for East Cleveland lines originating in the main office are handled in the same manner at the incoming trunk positions at East Cleveland.

These incoming trunk operators have no occasion to cut in on the talking circuit of a subscriber, and have no occasion to use their listening keys, except to secure a busy test. They have no means for ringing subscriber's bells, for, as above stated, the originating operator does this. The most modern practice decrees that the duties of an incoming trunk operator should be confined to receiving the orders over her order or call wires which are joined to her head 'phone, establishing the connections ordered up, and to disconnect when she receives the disconnect signal. The originating operator is the one who should have complete supervision of the trunking connection, and in case of any special calls, such as calls from pay stations or nickel-in-the-slot machines, this operator is the one who should stay in on the connection to find out whether the calling party has succeeded in securing the called-for party and to see that he deposits his coin in the slot machine. It will be noticed that the trunk circuits installed conform precisely with this rule.

A busy back signal apparatus has been installed at both offices to obviate the necessity of the incoming trunk operator cutting in on a subscriber's line to inform him that the line is busy, for it is plain to be seen that she would necessarily lose many orders for connection while so doing. If a line tests busy, she simply plugs into one of four busy jacks provided at her position and pays no attention to that particular cord until she receives the disconnect signal from the other office.

The power plant shown in Fig. 5 consists of two Roth motor-generators for charging the two sets of ten cells each of American storage batteries. These machines receive current from a 500-volt trolley circuit and deliver 30 amperes at 28 volts. There are also two Roth ringing machines to supply current for ringing the subscribers' bells, one having a 500-volt primary and the other being wound to take current from ten cells of storage battery, both machines giving 100 volts, pulsating and alternating. The busy back signal apparatus is driven by a 1/6-h.p. Roth motor, which is also supplied from the storage cells. These machines are mounted on a specially designed iron frame-work, which is covered with paneling stained to match mahogany.

The power board is an Italian marble slab 60 x 60 x 1¼ ins., with polished surface and beveled face edges, mounted in an iron frame and shown at the right of Fig. 5. On this are mounted a Weston voltmeter of the round pattern, flush type, double scale, reading from 0 to 600 and 0 to 60, dead black finish with copper trimmings, and a Weston ammeter, round pattern, flush type, with six shunts and 100-ampere scale, finished the same as the voltmeter. Each of these instruments is controlled by switches having copper-plated hand wheels with index plates stamped for eight and six circuits, respectively. Two copper-plated Midget, 28-volt under-load and over-load I-T-E circuit-breakers protect the charging circuits. Twelve all copper back-connected jack-knife switches are also provided, eight on the charging and four on the discharging circuits.

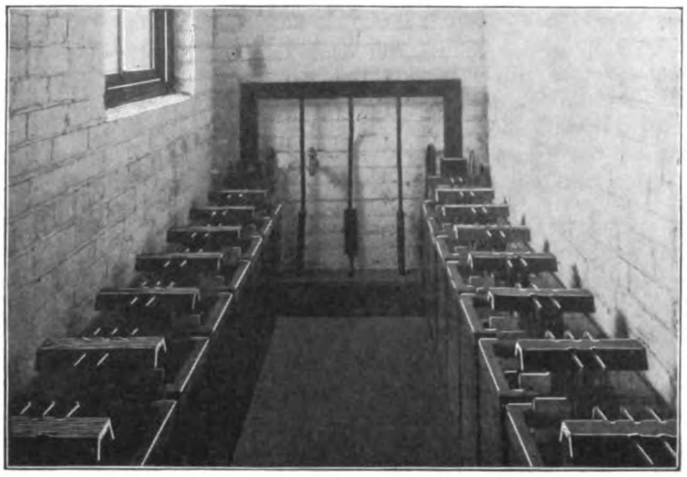


FIG. 6.—VIEW OF STORAGE BATTERY PLANT.

The battery plant consists of two sets of American storage battery, each set comprising ten cells, located as shown in Fig. 6. The elements are Y2 in Y4 lead-lined tanks, and the cells have a capacity of 100 ampere-hours each, which is sufficient for the present line equipment; larger tanks have been provided, however, so that plates may be added as the exchange grows. From the batteries and from the power board leads are carried direct to a fuse board which consists of a slate slab 42 x 60 x 1¼ ins., mounted in an iron frame and located adjacent to the power board, as shown at the extreme right of Fig. 5. On this board are located fuses for all of the circuits. Individual rubber-covered wires, No. 20 B. & S. gauge, are brought from each strip of twenty line lamps, from each set of supervisory or disconnect signals and from each strip of 20 line relays. Each operator's transmitter is fed by a twisted pair of No. 18 B. & S. gauge rubber-covered wires. The battery connection is carried to each cord circuit for talking in 15-pair switchboard cable, each fused on this board. The connections are all soldered to the fuse studs on the rear. These studs project through to the face where each one is fitted with a cap screw, under which the fuse is held. Each set or group of fuses is numbered or labeled so that the "trouble" man may readily locate any circuit which he may wish to open for testing.

The building is lighted throughout by electricity, the switchboard being illuminated on the front with three 110-volt 16-c.p. lamps. The lamp brackets are finished in black and are provided with one-half-green shades. On the rear each section has a porcelain base keyless socket and lamp located in the roof. The power and distributing rooms are equipped with sufficient lamps to thoroughly light the apparatus.

Since the opening of this office a few weeks ago, the number of subscribers has increased so rapidly that it has been necessary for the telephone company to immediately add one section of 480 lines to the present equipment of 600 lines.

THE MODERN HORIZONTAL TUBULAR BOILER.

The horizontal tubular boiler is a peculiarly American type, which has come into general use during the past thirty or forty years. In England, according to an estimate published by Mr. Edward G. Hiller, the horizontal tubular boiler forms less than 1 per cent of the boilers now in use, while in this country it is more common than any other kind. It has a number of features that have conspired to bring it into favor with manufacturers, and probably engineers also. Its first cost per horse-power is comparatively low—lower, perhaps, than for any other boiler on the market. With good feed-water it is easily kept clean and requires very little attention. This much can be said, in fact, of almost any boiler; because good feed-water is a prime essential for any steam plant, and when it can be had, things are always apt to run along pretty smoothly. But it can be said, truthfully and without forgetting the good points of other kinds of boilers, that the horizontal tubular type can be used successfully with water that would bring other types to grief. The vulnerable spot, in this kind of boiler, is the tube ends; and as the back head is the one that is exposed to the flames, it is there that the greatest trouble is experienced.

The shell will often stand a large amount of scale without injury, and yet it must not be neglected. Fragments of scale, wherever formed, fall to the bottom of the boiler when they flake off, and this is the best possible place for them to lodge, as the shell plates present a large area, which is covered by a large body of water. The removal of such accumulated scale must be attended to in an intelligent manner, however, for many boilers have had their days of usefulness shortened by neglect or lack of judgment at this point on the part of the attendant. A case which recently came to the writer's notice illustrates this point very well. A paper manufacturer had two 72-in. horizontal tubular boilers, and as the feed-water was not of the best, he made a practice of opening and cleaning them every two weeks. When they had been in use about three years he changed his fireman.

Some six months later the new fireman summoned the owner and told him the boilers were acting strangely. Upon investigation a well-developed bulge was found on the bottom of one of them, about over the bridge wall. The fire was drawn and the boiler allowed to cool off. The boiler doctor was then summoned by telephone, and was asked to explain the case. He thought the bulge was due to scale; but the owner was positive that that could not be so, as the boilers were emptied and washed out only the day before. The boiler was finally blown off, and when the hand plates were taken out, a large quantity of scale, composed of small particles that had been baked together into one solid mass, was found directly over the bulge. The gaskets on the hand plates were soft and fresh, showing that they had been off the day before, so that the fireman's story that he had cleaned everything out appeared to be quite true.

A little further investigation showed that although the fireman had acted in good faith, he had erred by using the wrong kind of implement for cleaning. He had used a hoe with a handle only four feet long, and had not been able to reach in far enough to draw out the scale that had caused the bulge. The only way to make sure of the condition of a horizontal tubular boiler, when cleaning out, is to make a torch by tying a piece of waste on the end of a pole. The waste is to be saturated with kerosene oil, and then lighted and pushed in through the front hand hole, clear to the back head. This will light up the interior of the boiler and all scale can be located.

It will not be necessary to give an elaborate mechanical description of the horizontal tubular boiler, because its construction is familiar to almost everybody and is well shown in the accompanying engraving. It may be said, however, that there has been a radical change, during the past ten or fifteen years, in the details of the construction of this boiler. The tendency has been, and is, always toward higher pressures and greater capacity. The boiler-maker of to-day is better educated than he used to be, because competition has compelled him to be up to the times, both in tools and in the class of workmen that he hires, in order to get his share of the business. Shell boilers were formerly built with their longitudinal seams single-riveted, except in the case of the larger sizes, and it was not at all uncommon to meet with a 60-in. boiler with all its joints single-riveted. But a change has come over all this, and to-day it is rare to find a boiler even of small diameter (unless used solely for heating purposes) in which the longitudinal seams are not double-riveted, at least.

Formerly boiler-makers had an idea that rivets should be pitched quite close in order to make tight joints, and templets were used for laying off the holes for different sizes of boilers. The same size of rivet and the same pitch were used, in most cases, for all thicknesses of plate; except that when it was found that the rivet did not have body enough to overcome the spring of the plates and hold them properly together, a larger sized rivet was employed. Later it was found that by pitching the rivets further apart a tight joint could still be made; and as this course required less rivets to be driven, which meant a corresponding saving of time and labor, the wide pitch was generally adopted. Some of the makers even went to extremes in this change of practice, and by pitching the rivets too far apart, produced joints that were even poorer than those with the close pitch.

The almost universal adoption of wide pitch has been due, in large measure, to the influence of a few men of advanced ideas, who have given much time and thought to the construction of riveted joints, and to the methods of calculating their efficiencies; and the boilers built by reputable builders of to-day will be found to have the rivets pitched properly in most cases—that is, the shearing strength of the rivets will be found to be substantially equal to the tensile strength of the part of the plate that lies between the rivet holes. The double-strap butt joint is coming into use quite largely now on boilers 60 ins. or more in diameter. It is an excellent joint, far superior to the ordinary double-riveted form, and it may be strongly advised for boilers of even smaller diameter, if they are to carry high pressures.

No bracing is required in the horizontal tubular form of boiler, except on the segments of the head that are not supported by the tubes and the flanges of the heads. In some cases, in which the water is bad, the tubes are set higher than is shown in the engraving, and a manhole is put in the front head, under the tubes. In such cases it is necessary to brace that part of each head which lies below the tubes; but ordinarily the segment of the head that lies below the tubes is not large enough to require any bracing.

There are several different kinds of bracing in use, some of which are favored by one maker, and some by another. The so-called "longitudinal brace," which runs straight through the boiler from head to head, is met with more frequently than formerly. It is made in two styles, one of which is fastened with a jaw and bolt to stiffening bars that are riveted to the heads. This is a very effective brace, but it has the disadvantage of rendering the interior of the boiler less accessible than it would be with the oblique shell braces, shown in the engraving. The other style of longitudinal brace passes through channel bars on the heads, and is fastened with nuts on the outside of each head, and lock nuts on the inside. If this brace is properly put in, it has all the advantages and disadvantages of the other form just described; but there are some points about it that call for additional consideration. Great faith must be placed in the judgment and intelligence of the workmen who screw up the nuts. How much strain does it take to make them tight? And what will be the effect upon these nuts, in the course of time, of the heat to which they are more or less exposed? It is not easy to answer these questions, and yet they represent uncertainties that are of great importance.

Diagonal bracing, in which the braces run from the head to the shell, as shown in the engraving, is met with more commonly than the longitudinal style. Here, also, there are several methods of arranging the details. Sometimes the brace is fastened with a jaw and bolt to tee-bars, or angle irons, that extend across the head horizontally. Sometimes it is secured in the same way to bars that are riveted to the head radially. Sometimes, too, the brace is forged up with a solid crowfoot, which is riveted to the head directly, without the use of tee-bars. Any one of these forms is good, provided the workmanship is satisfactory and the braces are numerous enough.

The methods of setting the horizontal tubular boiler are as numerous as the kinds of bracing; yet they may be all classified, in a general way, under the two headings of "overhung fronts" and "flush fronts," according as the front end of the boiler does or does not project out into the fire room, beyond the setting. The flush front makes the neater appearance, but there is more chance of injury to the boiler from it than from the other style. The bricks that lie in the space over the fire door and under the front end of the boiler must be kept in place, or there will be serious danger of burning the dry sheet, and many boilers have been badly damaged by carelessness in this particular. When the overhung front is used, the dry sheet projects out beyond the setting, and hence if any of the bricks

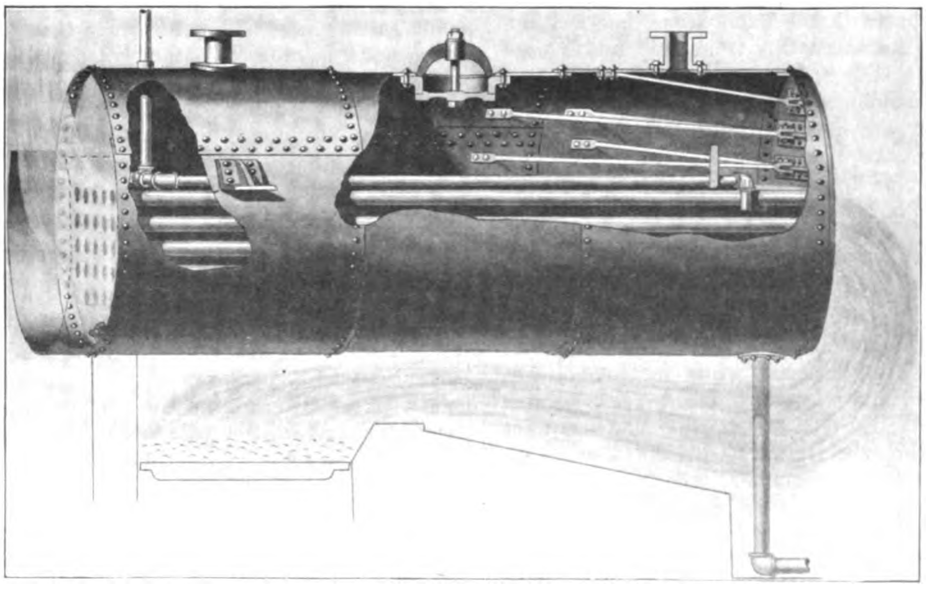


FIG. 1.—MODERN HORIZONTAL TUBULAR BOILER.

fall away from over the fire doors, the boiler itself is not injured, although the cast-iron front is by no means improved by exposure to the heat of the furnace.

The feed pipe may be led into the boiler in various ways, but the method shown in the engraving is one of the best. It here enters at the top of the shell, through a bushing. The internal part is screwed into the bushing, and it then drops down to within two inches of the tubes. At its lower end this pipe is fitted with a tee, from which branch pipes extend toward both sides of the shell, where they turn and pass backward along the shell to within about 18 ins. of the rear head. To prevent the two branches of the feed-pipe from chafing the tubes, they should be supported at the back end of the boiler by hooks forged from flat bar iron and attached overhead to a brace, or secured directly to the shell by a rivet. One of these hooks is suggested in the engraving. This method of introducing the feed from the top of the shell appears to have a material advantage over the commoner one of passing it in through the front head, as in the latter case the gases in the front connection affect the brass pipes that are usually employed for feed connections, and the life of the feed pipe at this particular point is shorter than elsewhere. In flush front settings, too, the brickwork has to be torn away to some extent in making repairs to the pipe, in case it enters through the front head; while in the construction here shown all parts of the pipe can be easily reached.

The blow-off pipe, if it is to answer the purpose for which it is intended, should be attached to the bottom of the shell, and not to the back head, as is sometimes done. Much trouble is often given by blow-off pipes becoming burned by direct exposure to the flame from the furnace; and, to avoid this trouble so far as possible, it is recommended that the floor of the combustion chamber be arranged substantially as shown in the engraving. The cavity or depression into which the blow-off pipe drops, will protect the elbow and the horizontal pipe from the hot gases. This same object is sometimes achieved by continuing the pipe still further down, so as to bury the horizontal part below the paving. The construction shown in the engraving is believed to be superior, however, because, while it accomplishes the same purpose, it also leaves the pipe perfectly free to expand and contract without straining itself, and also leaves it quite accessible. The sooty matter which lodges in the combustion chamber will soon cover the elbow and the horizontal part of the pipe, and protect them quite as effectively as a layer of brick.

The course of the gases, as they pass from the furnace under the boiler and back through the tubes, is sufficiently indicated in the illustration. In some cases an arch is sprung over the top of the shell, so as to provide a third return for them; but since this invites overheating of the shell, and does not add much to the efficiency of the boiler, it is not good practice.

THE ELECTROLYTIC PRODUCTION OF SODA AND CHLORINE.

BY ERNEST FRANKE.

If a solution of sodium chloride (common salt) be treated electrolytically with an insoluble positive electrode and a negative electrode of mercury, sodium will combine with the mercury, forming an amalgam, while chlorine will be evolved at the positive electrode. The amalgam will readily part with this sodium in water or steam as caustic soda. Pure caustic soda being obtained by this method, a saving of sodium chloride is effected, and a difficult and expensive refinement of the caustic soda lye obviated. Sodium being strongly electro-positive, has a tendency to oxidize, although combined with mercury as an amalgam, and forms caustic soda if it remains in the electrolyte for a definite time, even if separated from it by a porous wall. This tendency is especially noticeable shortly after closing the circuit of the cell, in the diminished current and increased voltage. In order that the sodium, combined with the mercury, may not be redissolved by the electrolyte from which it was formed, thus causing a loss, the amalgam must be removed from the electrolyte as quickly as possible. It may then be freed from the sodium and the mercury replaced in the cell.

While the principle is simple, the method is not easily followed in practice, and for this reason many inventors use diaphragms in connection with the mercury cathodes. The principal requirements for processes which use mercury as cathodes are the following: 1. Small quantities of mercury used, to reduce the first cost. 2. Rapid circulation—that is, rapid removal of the amalgam from the cell. 3. The anode should have a larger surface than the cathode, in order to obtain great current density on the cathode and thus prevent a loss of sodium. 4. No waste of mercury. 5. Tenacity of the cell-material against the influence of the sodium amalgam and chlorine. A considerable advantage would be gained by dispensing with the diaphragm and avoiding all the trouble connected therewith.

In using mercury as a cathode, the size of its surface is the main feature. The larger the surface, the greater will be the current passed through the cell at a given e.m.f.; if we also enlarge the surface of the anode, the smaller will be the quantity of mercury required per unit of work done. It would be impossible to use a cathode consisting of a thick cylindrical stream of mercury, but by spraying it the inactive portion of the mercury will be reduced to a minimum, while the effective surface will be made a maximum. This method possesses many advantages. The vertical position of the electrodes facilitating the escape of the chlorine gas, while the distance between anode and cathode may be made so small that the cell will require very little space. The internal resistance of the cell will be unusually low and its capacity large, it being possible to locate the mercury cathode between two anodes, thereby utilizing it to the highest degree. In large cells both sides of the intermediate anodes can also be used.

The amalgam, which falls to the bottom of the cell, may be protected from reduction by a layer of some inert liquid, such as sulphide of carbon, chloroform, etc. During its entire flow the mercury is under the influence of an anode having a considerably larger surface; a reduction of the amalgam during the flow is therefore out of the question; and since one layer of the amalgam is immediately covered by another, the inert liquid may be entirely dispensed with, if the quantity of amalgam leaving the cell is equal to the amount of mercury entering it. The result of rendering impossible the reduction of the amalgam is the highest obtainable production of caustic soda and chlorine. Experiments with free flowing mercury electrodes have given an efficiency of 98 per cent. The cells are very simple, as the mercury only falls through the electrolyte; they may be made from such material as stoneware, and require but little attention. There is scarcely any chance for them to get out of order, and no possibility for any waste of mercury, as a union of the metal with the separated chlorine in the cell is completely prevented by the large surface of the positive electrode.

A most important item is the quantity of mercury required to maintain continuous streams so as to obtain certain results. Experiments show that 2 grams (about 0.0705 oz.) of metal per second are necessary to maintain the flow in a concentrated solution of sodium chloride with an average length of 6 to 8 centimeters (2⅜ to 3.15 ins.). Such a stream being delivered between two carbon anodes in a warm concentrated solution, the current from the carbon to the mercury is about 0.7 ampere with an e.m.f. of 4 volts. The distance from anode to anode in this experiment was about 3 centimeters (1 3/16 ins.). By using platinum anodes, the current required was 1 to 1.2 amperes. For a current of 160 amperes at about 4 volts, 500 grams (1.1 lb.) mercury per second were required with carbon anodes; but with platinum anodes the quantity of mercury required was reduced 100 to 150 grams (3½ to 5.3 oz.). These extraordinary results are due, in the first place, to the rapid escape of the amalgam falling to the bottom of the cell, which prevents the formation of counter e.m.f., and also the fact that the amalgam was unable to take up much sodium during its short fall.

Owing to the rapid circulation of the mercury-stream through the cell, the amalgam formed is not rich in sodium and is thus easily reduced outside the cell. Cells may be made of glazed stoneware, about 0.8 meter (31½ ins.) square, with alternate anodes and cathodes, the anodes consisting of a composition of platinum-iridium. Such cells will pass about 3000 amperes at 4 volts.

SOME OF THE SPECIAL FEATURES OF THE SYSTEM OF THE PORTLAND GENERAL ELECTRIC COMPANY.

The power plant of the Portland General Electric Company at Oregon City, Oregon, was among the first electrical water-power plants to be built for transmitting power to a large city on a large commercial scale. This plant was built in 1893 and has ever since been one of the largest, most substantial and most satisfactory in operation of any of the water-power transmission plants in the United States. The plant was described in the technical press at the time it was built, but a few words about some of its special features and the distribution system it feeds will not be out of place at this time.

In few hydraulic plants is there such a varying head as at Oregon City. The power-house is 14 miles above Portland on the Willamette River. A few miles below Portland this river flows into the Columbia and at some seasons of the year the freshets in the Columbia back up the water in the Willamette so that the head at the Willamette Falls at Oregon City is greatly reduced. At other times freshets on the Willamette increase the head. Taken altogether, the head is likely to vary from 18 to 40 ft. Turbines large enough to drive the generators at the lowest head would be hard to govern with the small gate opening that would be necessary at the highest head. Therefore to meet these varying conditions two turbines were installed on each generator, a large turbine for low head and a smaller one for high heads. The generators and turbines are on vertical shafts. The small turbines are directly connected to the shafts of the generators and the large turbines are at one side of the small ones, and when in use are belted to the generators. These belts are short and are thrown out of use simply by loosening a belt-tightening idler pulley.

The weight of the generator armatures is 16 tons and special provision is made for carrying this weight. The shaft has two different thrust bearings. One is a bearing in which the thrust is taken by a number of bronze rings lubricated by having oil forced under them at high pressure and the other is a revolving piston under which oil is forced at sufficiently high pressure to sustain about half the weight of the armature, the other half being sustained by the thrust bearing. The floating bearing was designed as a safety precaution to relieve the thrust rings in case they began to heat, but it is employed regularly to take about half the weight, as it is just as easy to run it so and saves some power that would otherwise go to waste in friction. The generators are 450-kw. machines and run at 200 r.p.m. It has been found, by running the armature with a small motor, that the thrust bearing used alone absorbs 25 horse-power with the 16-ton weight upon it, and when relieved of half its weight by the floating oil bearing the friction loss in the bearings is reduced to 10 or 12 horse-power. Oil for the lubricating and floating is supplied by an electrically driven oil pump, supplying the whole station. In case the pump fails and the oil pressure drops, a pump driven by a water wheel is automatically turned on. The oil pressure is maintained at from 150 to 175 lbs. per sq. in. In addition to the forced lubrication all bearings of any size are water jacketed. The provisions against shut-down are very complete.

The efficiency of the turbines in this station at full load as near as can be determined is given by hydraulic engineer Sullivan as a little less than 75 per cent.

The governors in the plant are all the Replogle electric relay type. The electric circuit on the magnets which close the gates is run up from the wheel pit into the dynamo room and in case a machine is to be shut down in an emergency the circuit can be closed down so the governor will shut the gate in about 18 seconds. The results obtained in regulation are good. As plenty of fly-wheel effect is absolutely necessary to the successful regulation of a turbine-driven dynamo on account of the impossibility of stopping the flow of water suddenly with safety or starting it quickly, it is common practice to run the large turbines of this plant idle when the small ones are doing the work, for the sake of the fly-wheel effect.

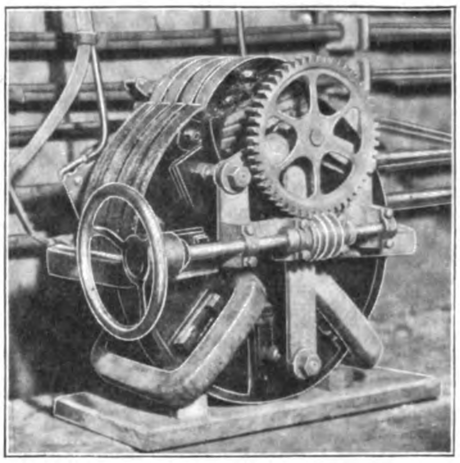


FIG. 1.—INDUCTIVE REGULATOR.

The station now has six direct-connected, 33-cycle, 450-kw., 3-phase, 6000-volt generators and three 600-h.p. turbines geared by bevel gear to a horizontal line shaft to which are belted some 5800-volt 125-cycle single-phase alternators brought from an old station. Besides this there are two 375-h.p. turbines direct-connected to 500-volt direct-current generators which serve for exciters and supply current to neighboring electric railway lines. The 6000-volt and 5800-volt machines supply direct a sub-station in the center of Portland, which will be mentioned later on. The machines supplying incandescent lighting circuits and those supplying railway and power circuits are run separately, but those on three-phase lighting circuits are run in multiple and those on the railway load in multiple. In operating the plant 24 hours 11 men are employed.

The company has two pole lines into Portland, one on the west side of the Willamette River and one on the east. The 6000-volt lines are run on glass insulators on pins 12 ins. apart. About the only trouble experienced on this line is an occasional cross during a storm.

The sub-station in Portland was laid out to meet conditions existing when it was put in, one of which was a 4-wire 330-volt system for low-tension distribution around the center of the city. This system has been continued. It is not considered an ideal one to operate by any means because of the difficulty of keeping the balance between the three circuits. It is fed from the three-phase generators and each transformer has four taps in its secondary for connection to the four distribution wires. At full load about 400 volts pressure has to be maintained between the outside wires of the system.

The residence districts are supplied from the high-frequency alternators. At the sub-station reduction is made from 5500 to 2000 volts and also to 1000 volts for distribution. At the sub-station are also rotary converters which supply about two-thirds the railway current used in Portland and also the 500-volt power circuits. All the small motors in Portland are run from 500-volt circuits. The station also has a number of old D. 62 railway generators running as motors, each direct-connected through a flexible coupling to a 100-light Excelsior series arc dynamo.

In all the incandescent lighting circuits on the four-wire system regulators are used for varying the voltage by hand at the sub-station. Between the generating and the sub-station communication is had mainly by gong signals. A code is used whereby the number of the circuit is first struck, followed by a signal to raise or lower the voltage. This is quicker and involves less work than telephoning. The gong is operated on an iron wire circuit with 500-volt current.

Several types of compensator regulators are used, all of which depend on the principle of a boosting transformer.

Mr. J. L. Thompson, assistant superintendent, has designed a home-made regulator which is being made in the company's shop at slack times. This regulator consists of a field magnet of laminated iron, made of some old armature rings, and wound with a coil connected in shunt across the mains. One of these regulators is shown in Fig. 1. The magnet ring has a circular opening at one point to receive an armature of laminated iron, on which armature is wound a single coil connected in series in the circuit to be regulated. This armature can be turned by a hand wheel so as to bring the plane of the coil either parallel with or at a right angle with the magnetic flux through the core. When the armature coil is at right angles to the magnetic circuit there is no effect on the circuit to be regulated, save the slight reactance of the coil itself. Turning the coil one way from this position raises the voltage and turning it in the other direction lowers the voltage. The device has the advantage of requiring no switch contacts for its operation, and of being cheap and easy to make up in a hurry, when to obtain a regulator from an eastern factory might take several months.

No fuses are used in the circuits between the generators and the step-down transformers—in fact the 6000-volt lines are entirely without fuses. The secondary lines from the step-down transformers are fused.

One peculiar feature of the company's business is that of furnishing a number of isolated plants with current during the light-load hours of the station; during the heavy load periods the engines and dynamos at the various plants are used in the usual way.

The system is under the general management of H. W. Goode and T. A. W. Shock is superintendent.

A COMPARISON OF DYNAMOS WITH SURFACE-WOUND AND SLOT-WOUND ARMATURES.

BY P. M. HELDT.

American manufacturers have practically entirely abandoned the surface-wound dynamo in favor of the slot-wound dynamo. The former type is at present only constructed for special purposes, such as plating and electrolytic work. In Europe, and especially in England, the surface-wound machine is still in the lead, manufacturers there always contending that the slot-wound dynamo is much more given to sparking than is the surface-wound machine. In the experience of the writer, dynamos in the United States spark less now than they did years ago, when they had surface and hand-wound armatures. This is not saying that the slotted core improves the conditions governing sparking, but that the conditions have been thoroughly analyzed in recent years and that machines are now built along lines which reduce the sparking tendencies to a minimum. The points of superiority generally credited to the slot-wound dynamo are, first, that on account of the short air-gap there is a considerable saving of magnetizing force; and, second, that as the conductors are buried in the iron, they are not so easily damaged as when lying on the surface of the core. The writer proposes to show in the following that for small machines of given weight and angular velocity, at least 50 per cent more output can be obtained if the armature is slot wound than if it is surface wound.

A number of years ago, a manufacturer who was then still building surface-wound dynamos noticed that his machines were considerably heavier than slot-wound machines of equal output and speed, built by his competitors. A 7½-kw. dynamo, for instance, running 1200 r.p.m., weighed 1400 pounds, while machines of this size with iron-clad armatures, only weighed 1000-1100 pounds. A calculation was made and it was found that by increasing the armature diameter, reducing the length of the field cores, and making the armature of the slotted type, an output of 12½ kw. could be obtained and the speed be reduced to 940 r.p.m.

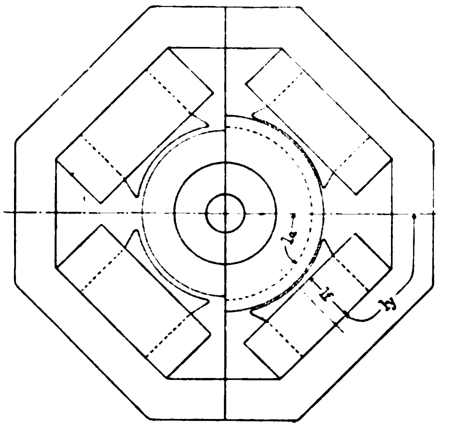


FIG. 1.—SIDE VIEW OF YOKE.

The machine referred to is of the quadripolar type, with radial internally-projecting poles. The yoke has an octagonal form, as seen in Fig. 1. The following are the data of this machine as originally constructed:

	Ins.
External diameter of armature discs...	10¼
Internal diameter of armature discs....	6⅜
Length of sheet iron core................	9
Thickness of cast iron end plates, each	½
Bore of field..................................	10[illegible]
Axial length of pole tips..................	10
Circumferential width of tips (length of arc)..	6¾
Minimum thickness of tips..............	⅜
Diameter of field cores..................	5¾
Length of field cores.....................	4
Radial depth of yoke......................	2½
Axial width of yoke........................	12

The armature has 84 sections, and for 110 volts is wound with two turns per section, of two No. 13 B. & S. wires in parallel. The winding is of the parallel or four-circuit variety. The number of effective conductors is therefore 168. The shunt field is wound with 96 pounds of No. 15 wire, B. & S. gauge. The magnetic calculation of this dynamo is as follows:

Flux (in armature) =

$$\frac{110 \times 10^8 \times 60}{1200 \times 168} = 3,274,000 \text{ lines.}$$

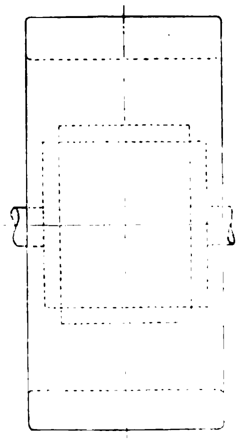


FIG. 2 —EDGE VIEW.

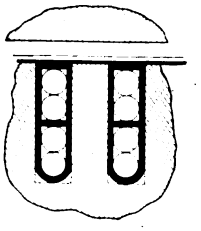


FIG. 3.—SLOT WINDING.

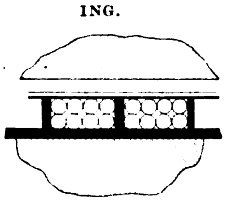


FIG. 4.—SURFACE WINDING.

The leakage coefficient is taken at 1.4, and the field flux is, therefore,

$$1.4 \times 3.274000 = 4,584,000.$$

The ampere turns to produce this flux are shown by Table I.

The total number of ampere turns for one magnetic circuit is 3263; for all four circuits, therefore, the number is 13,052 ampere turns. The shunt coils will have an internal diameter of 6 inches and an external diameter of 9¼ inches. The mean diameter is, therefore, 7⅝ inches, and the mean length per turn of wire is very nearly 2 feet. For rheostat regulation allow 15 volts, which leaves 95 volts to be applied to the field coils. Substituting now in the formula

TABLE I.

	Area, magnetic path, sq. in.	Length of magnetic path, in.	Density per sq. in.	Amp. turns required per inch length.	Amp. turns for each section of one magnetic circuit.
Armature.... ...	16.4	3	50,000	6	18
Air gap.............	66	[illegible]	24,800	7,750	2,540
Pole piece	46	¾	50,000	740	105
Magnet core.	26	4	88,000	30	120
" yoke	30	10	38,000	48	480
Total ampere-turns............				.....	3,263

ohms per ft. of shunt wire =

$$\frac{\text{e.m.f. (applied)}}{\left.\begin{matrix}\text{length of a turn}\\ \text{in feet}\end{matrix}\right\} \times \text{ampere turns}}$$

we find for the resistance per foot of the wire required,

$$\frac{95}{2 \times 13,052} = .00364 \text{ ohm;}$$

hence the resistance per 1000 ft. is 3.64 ohm. This is the resistance when the wire is hot. If we figure on an increase of temperature of 75 degrees Fahr., above the normal temperature, then the resistance increases in the ratio of 1.16:1. The resistance per 1000 ft. of the shunt wire, when cold, should therefore be $\frac{3.64}{1.16} = 3.14$ ohms, which is the resistance of No. 15 B. & S. wire, with which the machine is wound.

Following are the data of the slot-wound machine:

Output, 12½ kw.; voltage, 110; speed, 940 r.p.m.; number of sections in the armature, 96. The armature has a parallel or four-circuit winding, consisting of two turns No. 8 (B. & S.) wire per section.

	Ins.
External diameter of armature disc....	12⅛
Internal diameter of armature disc.....	6⅜
Length of armature core..................	8
Depth of armature slot....................	.660
Width of armature slot....................	.796
Bore of field..................................	12⅜
Axial length of tips.........................	8
Radial width of tips (arc)................	6.84
Minimum thickness of tips..............	⅜
Diameter of field cores..................	5¾
Length of field cores.....................	3¼
Radial depth of yoke......................	2½
Axial width of yoke........................	12

The shunt field coils are No. 16 wire, B. & S. gauge, 80 pounds, being wound on. The magnetic lines of this machine are

N (in armature) =

$$\frac{110 \times 10^8 \times 60}{940 \times 192} = 3,660,000.$$

The leakage coefficient is here about 1.2, so that in the field frame the magnetic flux amounts to

$$1.2 \times 3,660,000 = 4,400,000 \text{ lines.}$$

TABLE II.

	Area magnetic path, sq. ins.	Length of magnetic path, ins.	Magnetic density per sq. in.	Amp.-turns required per inch length.	Amp.-turns for each section of 1 magnetic circuit.
Armature core.	16.6	3	54,000	7	21
" teeth	23	0.66	80,000	18	12
Air gap...... ...	40	0.125	45,700	14,280	1,785
Pole piece .	40	0.75	55,000	210	158
Magnet core ...	26	3.25	85,000	24	78
" yoke...	30	10	37,000	46	460
Total ampere-turns................				....	2,514

Table II shows that the ampere-turns for one magnetic circuit are 2514, so that all four circuits require 10,056 ampere-turns. Allowing, as before, 15 volts for regulation, and having the same mean length of shunt turn as before, the resistance per 1000 ft. of the shunt wire is

$$\frac{95 \times 1000}{2 \times 10{,}056} = 4.721 \text{ ohms.}$$

Making the temperature correction as before, we find for the resistance of the wire, when cold,

$$\frac{4.721}{1.16} = 4.07 \text{ ohms,}$$

which is very nearly the resistance of No. 16 (B. & S.) wire. With this wire the machine was wound.

The factors which limit the output of a machine are heating and sparking. At present, machines are generally proportioned so that the limit imposed by the heating is lower than the limit prescribed by the sparking. The output of the machines under consideration was limited by heating. It might be suggested, therefore, that if there were a greater ratio of copper to iron in the smooth-core machine, it would compare more favorably with the slot-wound machine as regards output. The armature might be wound with three layers of wire of the same size of which it has two, in which case 11¼ kw. might be taken from it without causing any more heating in the armature than does the 7½-kw. output now.

But by making room for the extra layer of wire, we greatly increase the air-gap, and consequently increase the reluctance of the magnetic circuit. To force the same magnetic flux through this increased reluctance we would have to increase the size of our shunt wire, and in order to keep down the heating of the latter more wire would have to be used. In order to make room for this additional wire the field cores would have to be lengthened, which would also increase the diameter of the yoke and thus increase the weight of the machine all around. Not much, if anything, could therefore be gained in this manner. On the other hand, by making the changes described above the output of the machine was largely increased and the speed reduced, while the amount of copper in the machine and the total weight remained practically the same.

The iron-clad-armature dynamo is, therefore, lighter and more compact, and can be built at a lower cost than the surface-wound-armature dynamo of equal output and speed. The latter consideration, which concerns manufacturers and purchasers alike, certainly is responsible for the general adoption of slot-wound to the exclusion of surface-wound armatures.

◆

A NOTE ON THE USE OF THE ELECTRODYNAMOMETER.

BY FRED P. WOODBURY.

Although the electrodynamometer is large and clumsy, its suspension likely to get out of order or broken, and the mercury apt to be spilled from its cups, it possesses the almost inestimable advantage of accuracy; and when one becomes familiar with its few frailties it is more satisfactory than any other form of alternate-current ammeter, at least where accuracy is at all important. Unfortunately, the scale of the dynamometer does not read directly in amperes, but in degrees, and it is necessary to apply the formula $C = K\sqrt{D}$; where C = current, K = a certain definite constant representing the stiffness of the spring of the dynamometer and varying with each instrument, and D = deflection of the torsion head pointer in degrees of the scale.

This difficulty may be overcome in several ways. A table can be made for each instrument, giving a column of degrees, and adjacent to it a column of corresponding amperes; or, a curve may be made on cross-section paper, scaled in degrees horizontally and amperes vertically. The curve is preferable to the table in that it shows the exact current for every degree, while the table is not likely to be made with steps of less than five degrees, leaving the intermediate points to guesswork. On the other hand, it is much easier and quicker to read the table. The chief objection to both of these methods is that with even a slight change of the calibration of the instrument they become useless and must be re-calculated from the formula, using the new constant.

The ideal way of arriving at the desired result is by the use of the slide rule. By its use the constant of the instrument may be changed indefinitely and the complete table is always at hand. By simply setting the index or extreme left-hand mark of the C scale opposite the value of the constant on the D scale, the degrees of deflection may be read on the B scale, and the corresponding current will be directly below on the D scale. So, after correctly setting the slide, it is only necessary to use the runner or cursor. Thus, with a constant of 3.3, what is the current indicated by 8°? Set the left-hand end of the C scale at 3.3 on the D scale and slide the runner up to 8 on the B scale; at a glance at scale D it will be seen that the current is 9.33 amperes.

A word in regard to balancing dynamometers may not be out of place here, as the accuracy of the instrument largely depends upon the keeping of the two coils in proper relation to each other. First loosen the clamp that is always provided for holding the movable coil off the suspension when not in use. Some dynamometers are fitted with a spirit-level for balancing, but this is unnecessary. The inside terminal of the movable coil passes through a hole in a guide to keep it in proper position. By the manipulation of the three leveling screws on the bottom of the instrument the movable coil can be made to hang clear of the guide and in the center of the hole through which it passes; at the same time the pointer of the movable coil should rest on zero, when the torsion head pointer is also set on zero. At first this adjustment may cause some trouble, but after a little practice it will be easy. The object of this balancing is to bring the axes of the two coils coincident and their planes at right angles.

As the suspension locates the top of the movable coil we have the three points necessary for the location of the plane. Sometimes on account of the faulty setting of the spring, the pointer of the movable coil will not come back to zero with the bottom of the coil correctly located. In this case the torsion head pointer may be deflected forward or back until it does come to zero. After this, care must be taken to correct the reading of the torsion head pointer by the amount it was necessary to deflect it. Thus if the torsion head pointer was moved forward 4° to bring the pointer of the moving coil to zero, and on turning on the current it was necessary to move the torsion head pointer to 157° to take the reading, the correct reading would be 157° — 4° = 153°. This method does not materially affect the accuracy of the instrument.

◆

Discovery of India Rubber on the Banks of the Amazon. — The discovery of large forests of caoutchouc or India rubber on the banks of the Niera, one of the branches of the Amazon, has lately been announced. The forests are situated about eight days' journey from the center of the great tobacco plantations. Several German houses have organized an expedition for the purpose of securing the right to gather the product of the district, the inhabitants of which are said to be so poor that it is possible to obtain the rubber at a very low cost. A special route has been projected by way of Iquitos, a town that offers the best advantages for the handling of the rubber after it has been gathered.

◆

An Electrical Water Gauge.—An electrical indicator is employed with success by George Evans, who has charge of the electrical machinery at the big B. & M. smelter, Great Falls, Mont., for showing the height of water in a tank upon a butte several thousand feet from the works. A float is arranged so that it cuts in or out resistance in a circuit as the water rises and falls. The resistance is buried underneath the tank, so as not to be affected by the weather and changes in temperature. Down at the pumping station an ammeter is put in the circuit with its scale calibrated to correspond with the position of the float, so that the height of water in the tank is indicated directly by the ammeter needle.

RECENT TYPES OF AMERICAN AND EUROPEAN ENGINES.

NEW ENGINES FOR THE BROOKLYN EDISON PLANT.

In the leading article of our January number reference was made to the fact that two 5000-h.p. Westinghouse engines were in process of construction for the Bay Ridge station of the Brooklyn Edison Company. One of these engines has been completed and is now being erected in the station. The new engine differs considerably from engines of large output previously built by the Westinghouse Machine Works, as a glance at Fig. 4 will show. The engine is a cross-compound, with double-acting cylinders and Corliss valve-gear. The cylinders are 46 and 86 ins. in diameter, respectively, by 60 ins. stroke. The most economical rating of the engine at the normal speed of 75 r.p.m. is about 3750 horse-power, but the engine is capable of maintaining loads up to 7500 horse-power.

The valve-gear is a three-quarter cut-off Corliss gear, with straight motion on the steam side and a wrist-plate motion on the exhaust side; a heavy rocker-arm is interposed, of course, between the eccentric rod and the valve-gear proper on the steam side. The high-pressure valves have ⅝ in. lap and the low-pressure valves 1 in. lap, giving about 50° angular advance to the eccentric and obtaining thereby a comparatively quick opening of the valve. The complete gear is illustrated by Fig. 1 and a detail is shown to larger scale by Fig. 3. The designer, Mr. Cyrus Robinson, has departed from the usual construction in which the drop arm is put at the outer end of the valve stem, and has placed it inside the bonnet. This gives two bearings, one on each side, and allows the dash-pot to be located close to the cylinder, with a very short drop rod. This construction also permits the use of a long and large bearing for the hook and knock-off lever and allows the knock-off cams and governor connections to be placed at the outer position of the gear where they are more accessible. The valves are all of the double-ported Corliss type, located in the cylinder heads and as close together as possible so as to facilitate compact construction in the valve-gear. The cylinder clearances are 3 per cent in the high-pressure and 2 per cent in the low-pressure cylinders.

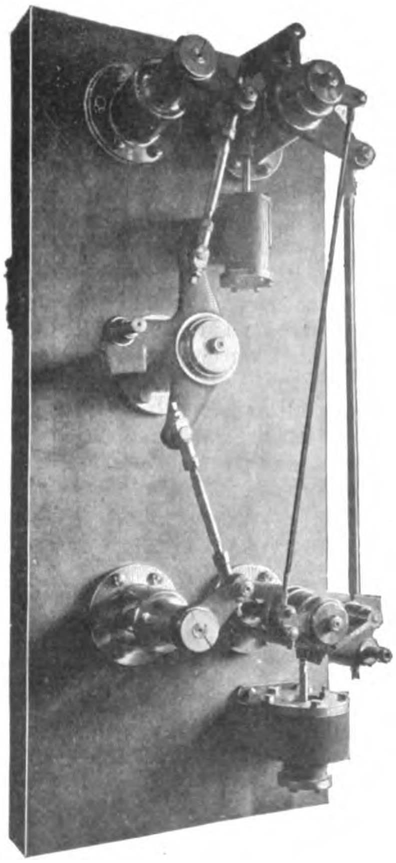


FIG. 1.—VIEW OF VALVE GEAR.

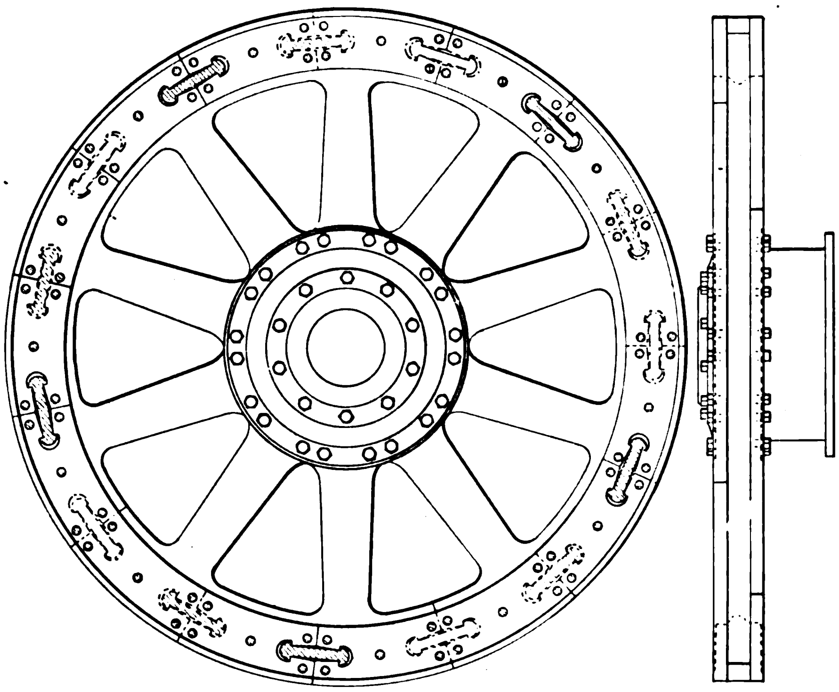


FIG. 2—THE BUILT-UP FLY-WHEEL.

Steam jackets are not used on either high-pressure or low-pressure cylinders. The Westinghouse Machine Company, builders of the engine, state that experience has convinced them that the value of a steam jacket becomes negative at about 600 ft. piston speed when the engine is in regular operation. A reheating receiver is employed; the reheater comprises 109 tubes, 12 ft. 6 ins. long and 3¼ ins. in diameter, giving a total heating surface of about 1500 sq. ft. It has been from time to time strongly advocated that reheaters proportioned to 1 sq. ft. per indicated horse-power should be used on cross-compound engines, but the builders say that their experience has shown such a reheater to have a negative value. A reheater of about the proportions used on this engine has value on light loads and in starting, and does not cut down the economy at full load. Steam at boiler pressure is used on the outside of the reheater tubes, the cylinder steam passing through them.

The connecting-rods are solid steel forgings, having solid ends and wedge-adjusted boxes; the length between box centers is 13 ft. 9 ins., which is 5½ crank lengths. The cross-head pins are 14 ins. in diameter and 14 ins. long; the crank-pins are the same size.

The shaft is a hydraulic forging of open-hearth steel, hollow throughout its length. The diameters are 39 ins. within the fly-wheel and 34 ins. in the bearings. The diameter of the hole through the center is 16 ins. The shaft weighs about 75,000 lbs., without the crank cheeks or the fly-wheel center. The cranks are of the fan-tail pattern and set 90° apart. The

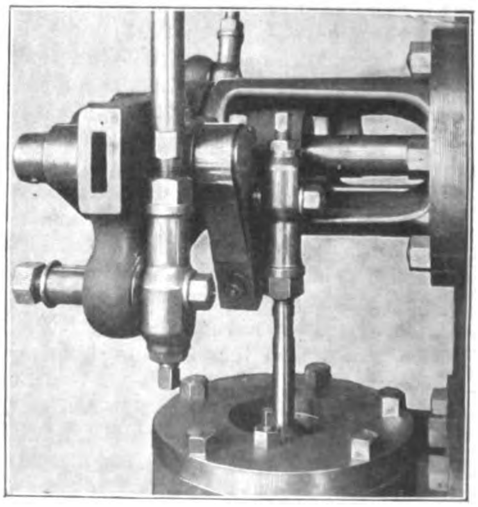


FIG. 3.—DETAIL OF VALVE GEAR.

fly-wheel is of the built-up type and is shown by Fig. 2. The construction is somewhat novel and is, we believe, original with the Westinghouse Machine Company. The fly-wheel segments and arms are made of cast-steel and the fly-wheel center is of air furnace iron. There are five center rim segments, each of which is cast integral with two of the arms; the use of five segments obviously prevents any two joints from coming diametrically opposite. The width across the face of the center rim segments is 12 ins. On each side of the center segments are disposed five plates, 6½ ins. wide, linked together and so located as to break joints with each other and with the center segments of the rim. These side plates are se-

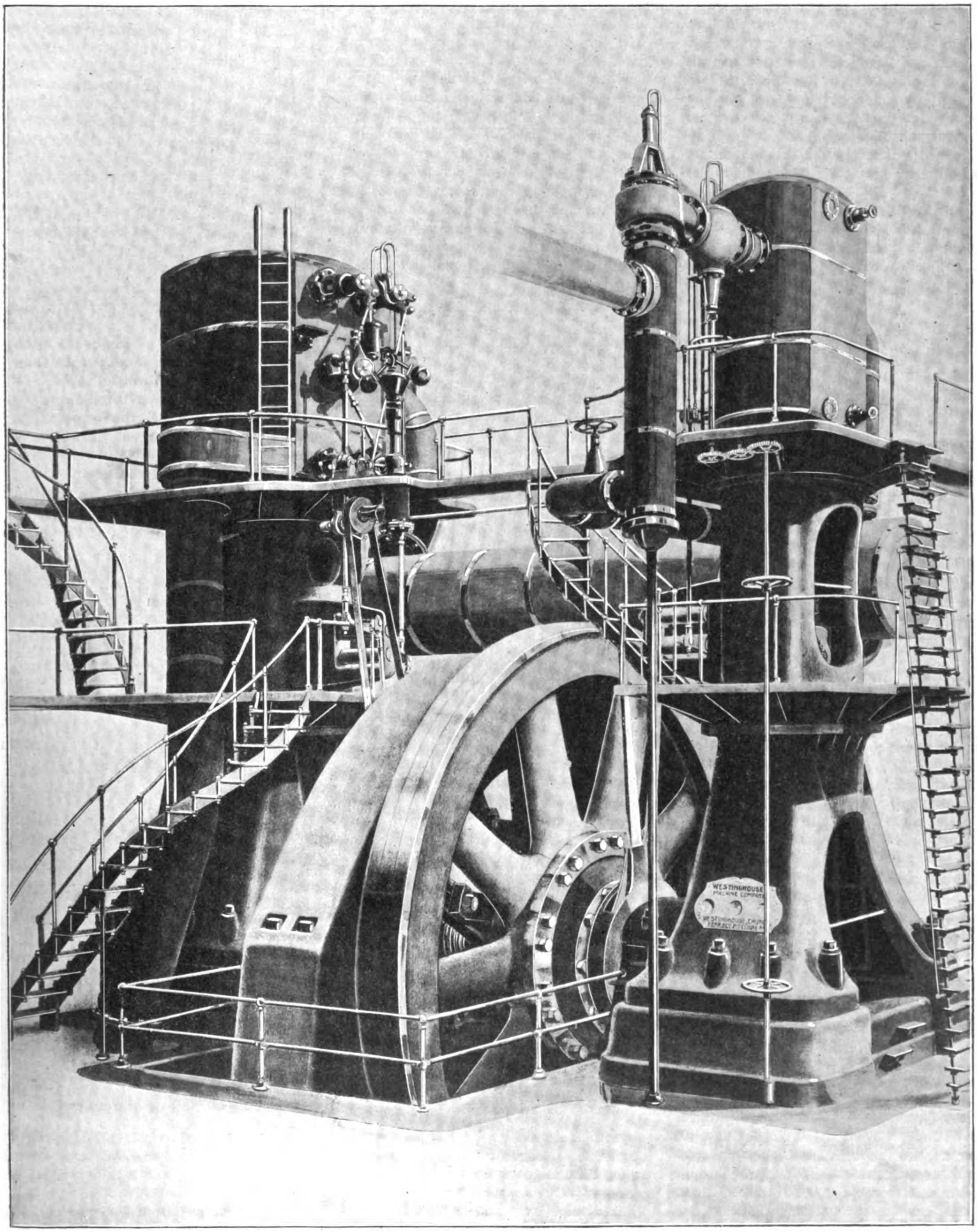


FIG. 4.—5000-H.P. CROSS-COMPOUND WESTINGHOUSE-CORLISS ENGINE FOR THE BAY RIDGE STATION, BROOKLYN.

cured to the center segments by means of 3¼-in. rivets. This construction results in practically three fly-wheels, each self-supporting as to centrifugal force. The outside segments bring no strain on the center segments, except that due to inertia effects. In the usual form of wheel embodying plate construction, the entire strain is liable to be brought on the links joining the center segments; with the construction here used this is impossible. The unshaded links in Fig. 2 are those of the center segments; the shaded ones are those which bind the side plates together. Fig. 6 is a semi-sectional edge view of the drum which is interposed between the fly-wheel and the rotating member of the alternator.

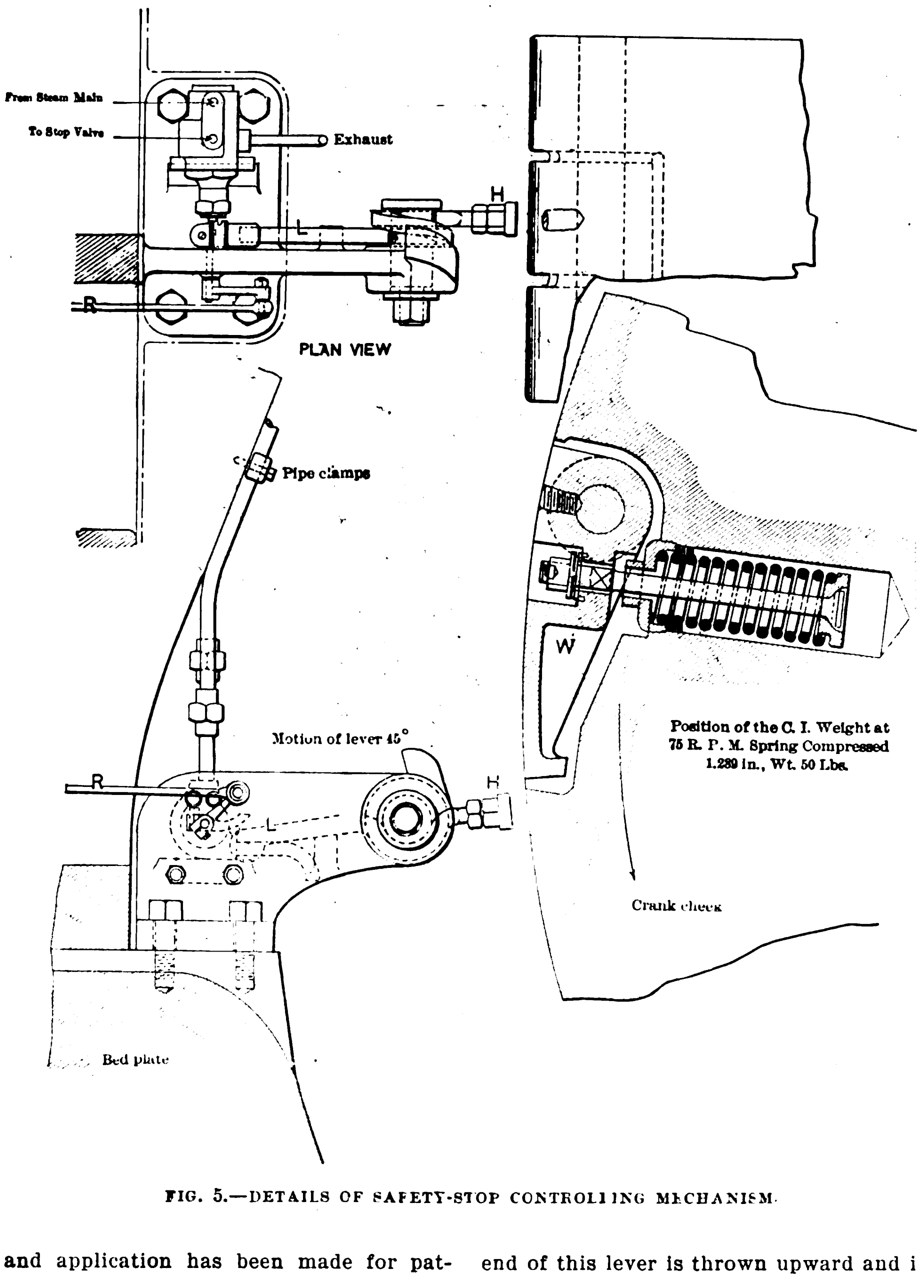


FIG. 5.—DETAILS OF SAFETY-STOP CONTROLLING MECHANISM.

Probably the most novel feature of the engine is the safety stop with which it is provided. This arrangement is original with the Westinghouse Machine Company and application has been made for patents covering it. The principal features of the safety stop are illustrated by Figs. 5 and 7, the latter illustration showing the stop valve itself, which is of the piston type. Under normal conditions the small cylinder in which the actuating piston, P, travels is open to the atmosphere so that the steam pressure in the main keeps the valve up. The pipe communicating with the upper cylinder terminates at its far end in a three-way valve which, when thrown out of the normal position, admits steam to the cylinder and closes the valve.

The controlling mechanism is shown in Fig. 6. A comparatively small weight, W, is pivoted in a recess in the face of the crank cheek and is normally held within the limits of the outline of the cheek by the helical spring shown. This spring is adjustable, of course, for any desired speed limit beyond which centrifugal force acting upon the weight overcomes the spring and throws the free end of the weight outward, when it engages the buffer head, H, on the short end of a lever pivoted on the engine frame. The long end of this lever is thrown upward and in its flight impinges upon the lever of the three-way valve above referred to, throwing this valve over and admitting steam above the actuating piston of the safety stop valve. The three-way valve is reset by means of the rod, R, which extends to the outer part of the engine frame within reach of the attendant. This also provides a means for shutting down the engine more quickly than could be done in the regular way should it be desirable to do so. When the three-way valve is reset it exhausts steam from above the piston of the stop valve and the latter is automatically reset by the steam pressure below it. It is evident that in case steam is shut off from the supply main the stop valve will drop by its own weight and close the port of the throttle valve.

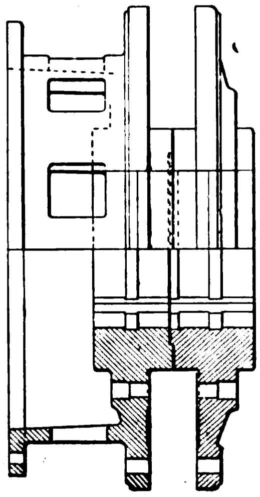


FIG. 6.—SEMI SECTIONAL EDGE VIEW OF DRUM.

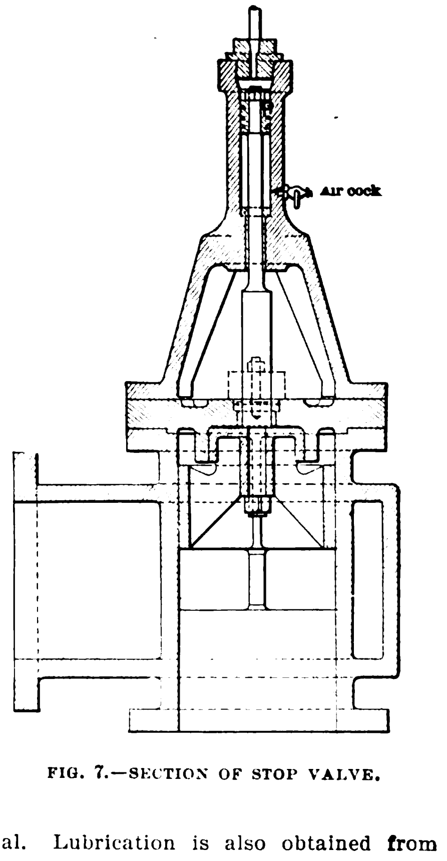


FIG. 7.—SECTION OF STOP VALVE.

The engine is arranged throughout for pressure lubrication, all the connections being brought to one point in which is placed a 1½-in. globe valve, which when closed shuts the oil off the engine. The main bearings are arranged so that a pressure of oil can be brought to bear at four points on the underside of the journal. Lubrication is also obtained from above the journal. The cylinders are lubricated by means of five feed pumps; there are three points of feed on the upper steam valve and two points of feed on the lower steam valve.

A RUSSIAN ENGINE FOR ELECTRIC LIGHTING SERVICE.

The use of variable cut-off for the regulation of speed, which has long been the universal practice of American steam-engine builders, is also becoming general among European manufacturers; this method being now used on the majority of engines designed for electric-light service excepting those built in England, many of which are still regulated by means of throttling governors. A recent type of engine in which is employed a variable cut-off mechanism of novel design is one built by Bromley Brothers, of Moscow, Russia. The accompanying engravings illustrate a triple-expansion engine of this type (together with the details of the valve gear) which was shown driving a Brown, Boveri & Co. alternator at the recent Paris Exposition. Fig. 1 is a sectional plan view from which it will be seen that the high-pressure and intermediate cylinders are mounted tandem and deliver power to a single piston rod, the low-pressure cylinder delivering power to a separate crank set 90° from the high-pressure crank. Between the two cranks the alternator is mounted. This is a revolving-field machine with the field magnet external to the stationary armature. The engine is provided with secondary valve-gear shafts mounted parallel to the cylinders and driven from the main shaft by bevel gears, which arrangement has become common practice with the builders in Continental Europe. The high-pressure cylinder is 13.386 ins. in diameter, the intermediate cylinder 21.65 ins. in diameter, and the low-pressure cylinder is 22.28 ins. in diameter. The stroke of the engine is 31.89 ins. All of the cylinders are steam jacketed; the live steam from the boiler passes through the jacket of the high-pressure cylinder before entering the steam chest, and the exhaust from this cylinder passes through the jacket of the intermediate cylinder before entering the steam chest of that cylinder; the exhaust from the intermediate cylinder in turn passes to the jacket of the low-pressure cylinder on its way to the steam chest.

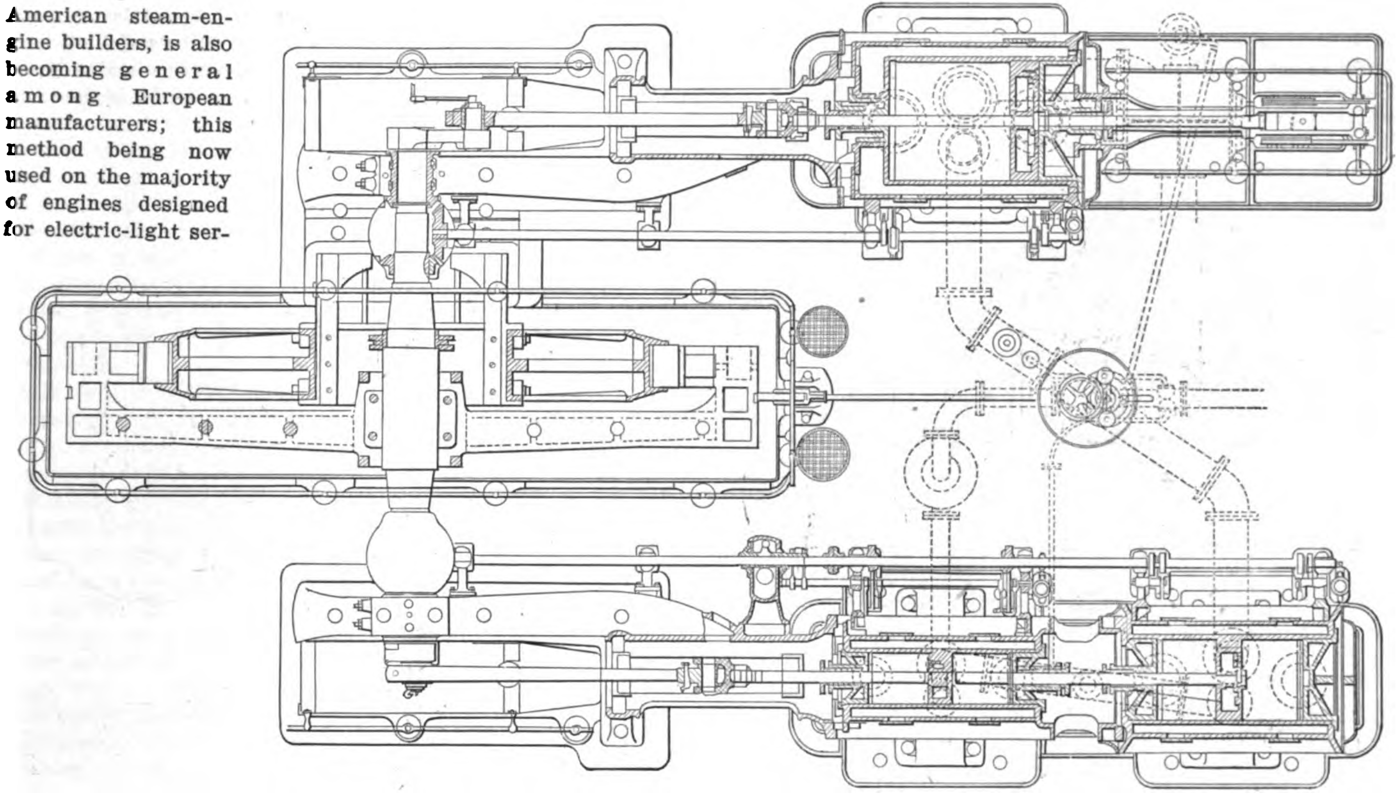


FIG. 1.—SECTIONAL PLAN VIEW OF ENGINE AND ALTERNATOR.

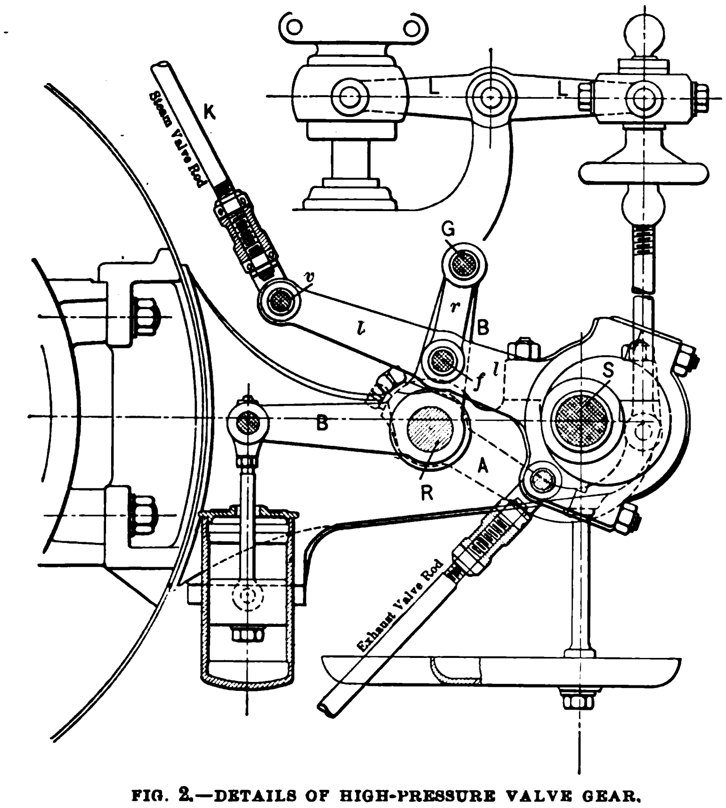


FIG. 2.—DETAILS OF HIGH-PRESSURE VALVE GEAR.

The valves are of the double-beat lift type, opened positively by the valve gear and closed by means of coiled springs applied to the valve stem, as shown in all of the engravings except Fig. 1. The steam valves of all the cylinders are on top, and the exhaust valves are beneath the cylinders. The governing is done exclusively in the high-pressure cylinder, the cut-off being fixed at the other two cylinders. Fig. 2 shows the details of the high-pressure valve gear at one end of the cylinder. The steam valve is lifted by means of a rod extending diagonally upward from the pivot, *v*, at the extreme end of the eccentric lever, or arm, *l*. The eccentric block is mounted on the secondary shaft, S, which was above referred to, and reciprocates about a fulcrum, *f*, which is a pin fixed in the end of a lever, *r*, hung from a pin, G, at the extremity of one arm of a bell-crank lever, B, B. This lever is mounted rigidly on a rock-shaft, R, and its position is controlled by the governor through the curved lever, A, attached to the same rock-shaft, and the governor rod leading up from the end of this lever to the horizontal arm, L. The right-hand end of the eccentric arm, or lever, *l*, is integral with the eccentric strap. It is obvious that the rotation of the eccentric block causes the lever, *l*, to oscillate about the fulcrum, *f*, giving the valve rod a reciprocating motion.

The point of cut-off is varied by the governor by twisting the rock-shaft and shifting the position of the pin, G. The motion of the eccentric arm, *l*, is not merely of an oscillating character; the arm reciprocates toward and away from the secondary shaft, and the movement of the pin, G, therefore varies the amount of travel given to the valve rod, which is due to the combined oscillation and endwise reciprocation of the eccentric arm, *l*.

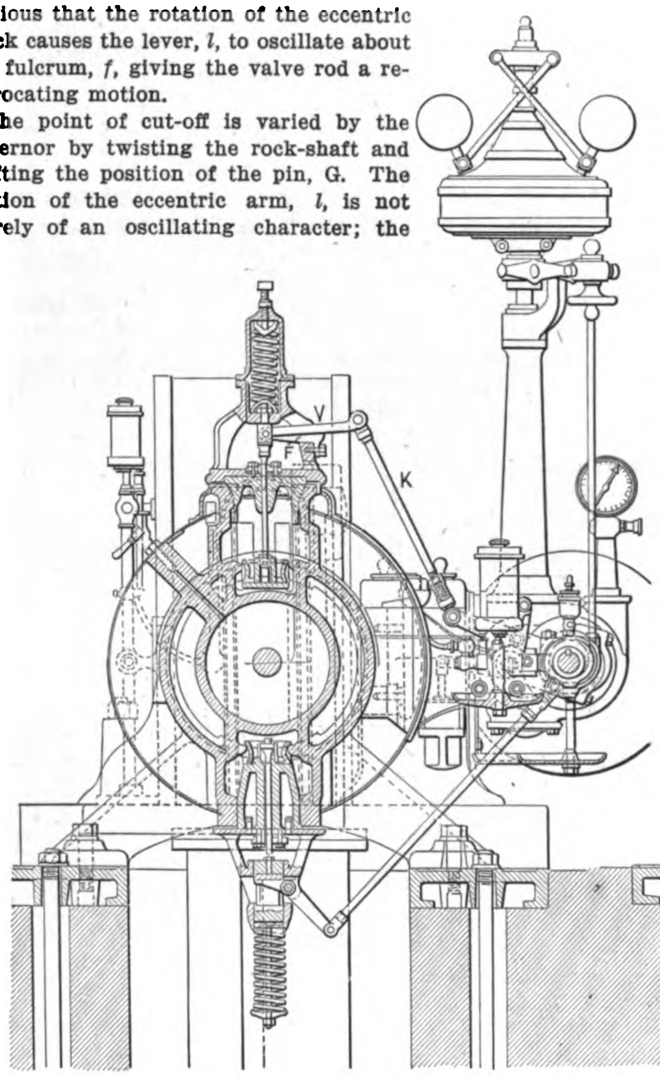


FIG. 3.—VALVE GEAR OF HIGH-PRESSURE CYLINDER.

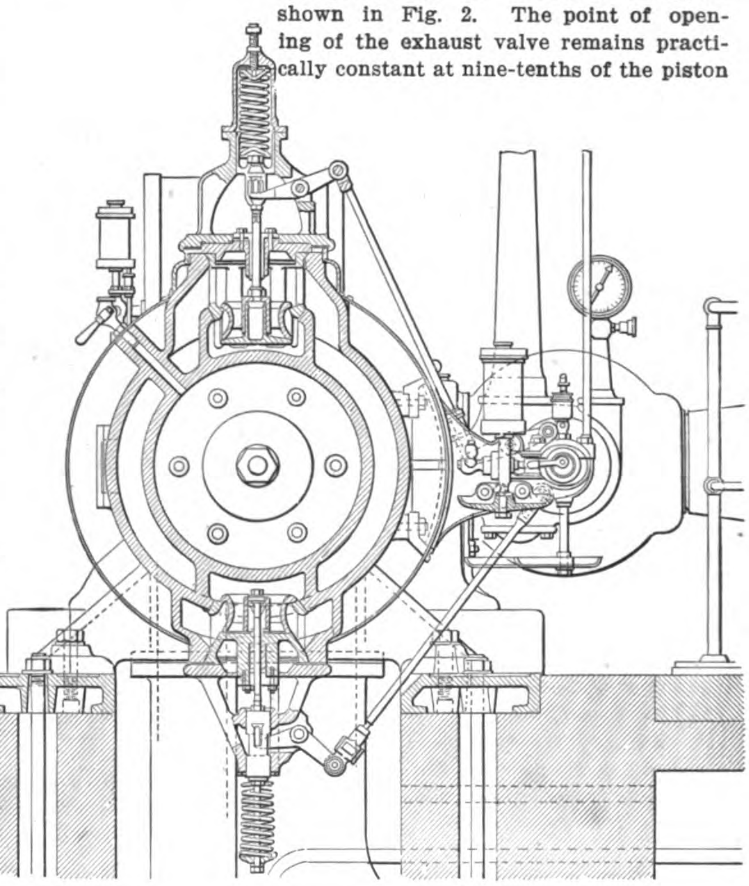


FIG. 4—VALVE GEAR OF INTERMEDIATE CYLINDER.

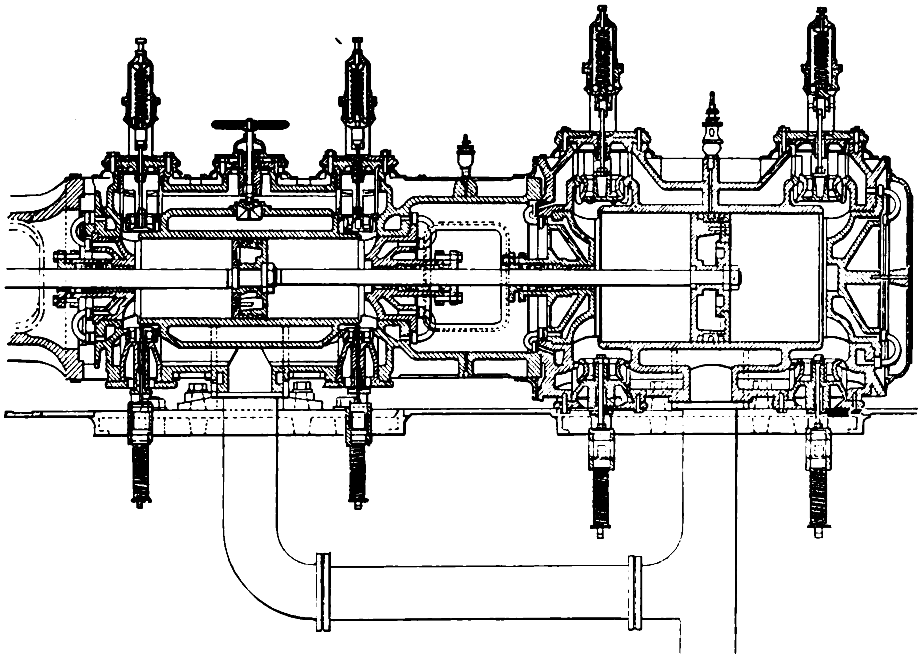


FIG. 5.—SECTIONAL VIEW OF HIGH-PRESSURE AND INTERMEDIATE CYLINDERS.

The effect of throwing the pin, G, over to the left is to give a later cut-off, as the travel of the steam-valve rod is increased. The rock-shaft, R, extends along the full length of the high-pressure cylinder and carries a duplicate mechanism at the other end of the cylinder for the operation of the steam valve at that end. The movement of the governor is damped by means of the dash pot, the piston of which is attached to the horizontal arm of the bell-crank lever, B.

The exhaust valves of the high-pressure cylinder are operated by rods extending diagonally downward from the valve gear and pivoted to the eccentric strap, as shown in Fig. 2. The point of opening of the exhaust valve remains practically constant at nine-tenths of the piston stroke, and the point of closing is fixed at 88 per cent of the succeeding stroke, so that the compression remains constant.

Fig. 3 shows the complete valve gear at one end of the high-pressure cylinder; the steam-valve rod, K, is pivoted at its upper end to a horizontal lever, V, the under surface of which is slightly convex and rolls on the flat horizontal surface of the steel fulcrum plate, F. The left-hand end of the lever, V, is pivoted to the valve stem. The effect of the arrangement described is to rapidly shift the fulcrum, which is the point of contact between the lever, V, and the plate, F, from the left-hand end of the lever over to the right as the valve is lifted. When the outer end of the lever starts downward under the pull of the rod, K, the fulcrum is at the extreme left-hand end of the plate, F. Owing to the convex under surface of the lever, V, a very small motion on the part of the lever serves to shift the fulcrum along the plate, F, until it reaches the extreme right-hand end of that plate. The ratio between the movement of the outer end of the lever and the valve stem is thus changed from a very high to a very low one; when the valve first starts to open the ratio is about 10 to 1, but is rapidly shifted to a ratio of 2 to 3, giving the valve a very rapid opening. The converse, of course, is true when the valve closes; it starts down at a comparatively high rate, which is lessened as it approaches its seat, by reason of the fulcrum being shifted along the plate, F, so that when the valve is finally seated it is done very quietly.

Fig. 4 shows the valve gear of the intermediate cylinder, which is the same as that of the low-pressure cylinder. Here the valves have a fixed travel and are operated by cams on the secondary shaft in connection with steel rollers. The steam-valve rod is attached to rocker-arms at both ends, the lower rocker-arm carrying a steel roller at one end which bears on the cam on the secondary shaft. The upper rocker-arm is bifurcated at the left-hand end and the bifurcations are provided with seats for a knife-edge on the valve spindle.

Fig. 5 is a sectional elevation of the high-pressure and intermediate cylinders, and Fig. 6 is a similar elevation of the low-pressure cylinder and the air pump. The piston rod of the low-pressure cylinder is extended through the back cylinder head and drives the air pump through the medium of a rocker-arm and links, as shown in Fig. 6. The tail-rod or rear extension of the piston rod does not depend for alignment upon the stuffing box through which it passes, but is provided with a cross-head shoe which travels along cross-head guides in the rear of the cylinder. The rocker-arm is pivoted far enough below its center to reduce the stroke of the air pump to about three-eighths of the stroke of the engine.

A peculiar feature of the air pump is that the connecting-rod which transmits the motion of the rocker-arm to the pump plunger is located within the pump piston rod. This is done, of course, in order to economize space, and also to minimize the side thrust of the pump piston rod upon the glands, the latter object being attained by the use of the unusually long connecting-rod, which is over 3 ft. long. The stroke of the air pump is 11.81 ins. and the diameter of the piston is 13 ins. The pump is double acting. The valves are rubber discs held down by conical spiral springs. The gland of each connecting-rod stuffing box is perforated in order to allow the leakage water to escape.

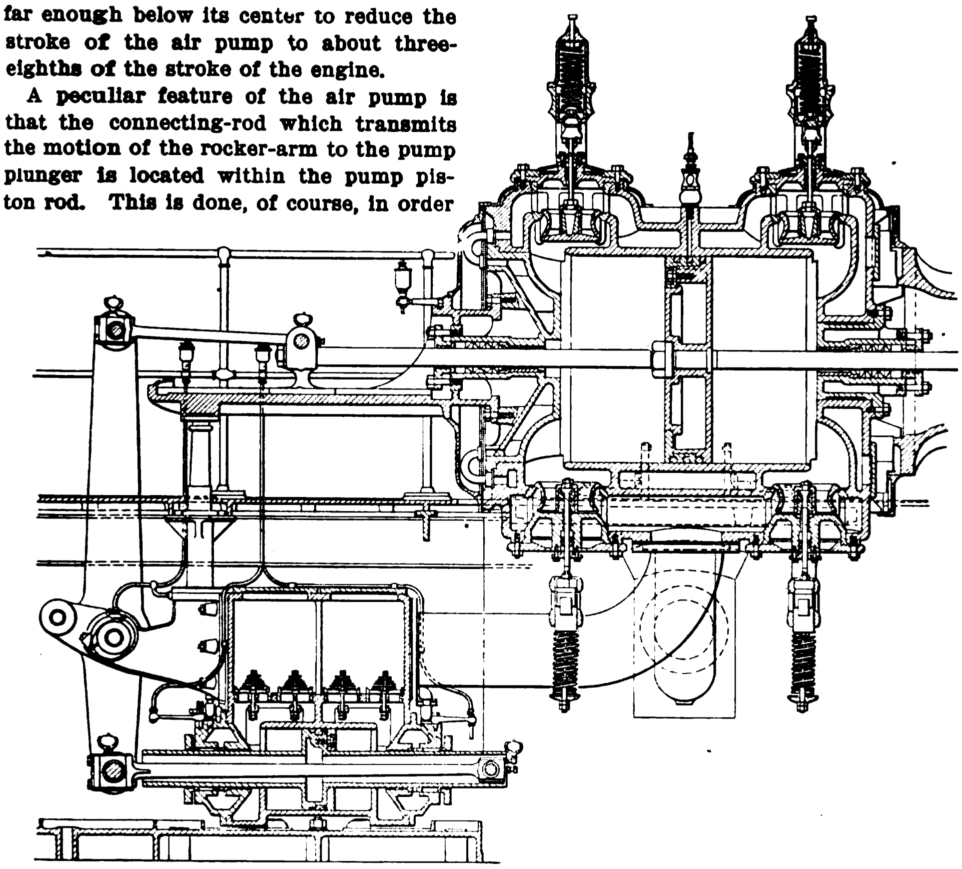


FIG. 6.—SECTIONAL VIEW OF LOW-PRESSURE CYLINDER AND AIR PUMP.

A jet condenser is used with the engine. With a condenser vacuum of 26 ins., a steam pressure of 175 lbs., and 28 per cent cut-off, the engine develops 350 horse-power; the normal speed is 92½ r.p.m. Without superheat, but with ordinarily dry steam supply, the steam consumption is said to be 13.23 lbs. per hour per horse-power.

STEAM ENGINE EFFICIENCIES.

BY A. F. NAGLE.

The engineer in charge of a plant hears a great deal about the "efficiency" of engines, but the word needs to be explained in order to be intelligently understood. "Efficiency" is a word which has come into use in engineering literature as an expression of the relation between actual results obtained in practice, and what might be expected under ideal, or theoretical, conditions. It is generally expressed in percentage, the ideal being taken at 100 per cent; the actual results obtained will be something less, of course, 50 per cent or 80 per cent, as the case may be. It is a really good word, for it gives the mind a clear idea of the relation of things and helps to suggest the probable amount of improvement one may look forward to.

Let us take a look at some of the different elements of the steam plant which are now compared by their efficiencies. To begin with, we have the furnace. It is possible to analyze coal by chemical methods, or, what is better yet, it can be burned in a coal calorimeter by means of oxygen gas, and thus the amount of potential heat which it contains can be accurately ascertained. It has been found that a pound of pure coal contains 14,500 B. T. U. (heat units). A rich bituminous coal will contain about 15,000 B. T. U., but the cheaper grades run in the neighborhood of 10,000 B. T. U. For scientific determinations it is useless.to speak of a pound of coal unless its calorific value, or heat-giving qualities, be stated. It is perfectly practical to transmit 85 per cent of the potential heat in the coal into the steam in a boiler. About eight per cent will go up the chimney, three per cent will be lost in radiation and cooling effects and four per cent will be lost by excessive air admission to the furnace. Owing to the difficulty and expense involved in ferreting out all of these various losses it is customary to group them all together and speak of the efficiency of the boiler as a whole.

The efficiency of a boiler may be accurately ascertained by testing the quality of the coal, weighing the amount burned, measuring the feed-water which goes into the boiler, and taking its temperature and the steam pressure. If, then, we can, by good design and construction, convert 85 per cent of the heat of the coal into steam, the efficiency of the boiler plant may be considered as having reached a very high state of perfection and but little, if any more, can be expected to be accomplished in the future. In general practice the results are not so good as this, 60 per cent and 65 per cent being nearer usual practice, but there is nothing in the nature of things, if we choose to pay for the talent and apparatus, to prevent us from realizing 85 per cent of the heat units contained in the coal. If the boiler can do so well as this, why cannot the engine do as well and convert, say, 85 per cent of the total heat delivered to it into power? The answer is, simply because it is a physical impossibility; the engine can do and does, however, convert almost that percentage of the available heat into power. The trouble is that the amount of heat available is only a comparatively small proportion of the total heat in the steam.

The only fair method, therefore, of considering the work done by an engine is to compare it with the maximum amount of work theoretically obtainable from the steam. Take the case, for example, of a multiple-expansion engine supplied with steam at 150 lbs. boiler pressure, working with 30 expansions and a condenser vacuum of 27.88 ins., giving a back pressure of one pound, and assume that the engine consumes 12 lbs. of steam per indicated horse-power-hour. The formula for calculating the amount of work which these 12 lbs. of steam should do is as follows:

$$W = \left[\frac{P\,(1 + \text{hyp. log. } R)}{R} - p \right] \times 144 \times R \times C \times S$$

P = absolute initial pressure = 165 lbs.
p = absolute condenser pressure = 1 lb.
R = number of expansions = 30.
C = cubic feet per pound of steam = 2.72.
S = pounds of steam used per i.h.p. per hour = 12.

Making the proper substitutions we have:

$$W = \left[\frac{165\,(1 + 3.4)}{30} - 1 \right] \times 144 \times 30 \times 2.72 \times 12 = 3{,}271{,}312 \text{ foot-pounds.}$$

As a horse-power = 1,980,000 foot-pounds per hour, the efficiency of the engine as a converter of available energy would be:

$$\frac{1{,}980{,}000 \times 100}{3{,}271{,}312} = 60 \text{ per cent.}$$

Now, here we have a fairly definite expression of how near we come to what might be done. With the use of superheated steam, which almost eliminates the loss due to condensation, and by otherwise improving the design and construction of the engine, it is claimed that engines can and do run on 9 lbs. of steam per indicated horse-power per hour. That would represent an efficiency of $\frac{12 \times 60}{9} =$ 80 per cent, which would be as near perfection as human skill and intelligence could be expected to come. Combining such an engine with a boiler of 85 per cent efficiency, the resultant would be a plant efficiency of 68 per cent, ignoring the small pipe losses.

If we should follow the custom of considering the potential energy in coal as something that may be utilized entirely, and compare this with the amount of work actually obtained, the result would be very misleading. Thus a pound of coal containing 14,500 B.T.U. has a potential energy of 14,500 × 778 = 11,281,000 foot-pounds. Assuming that the feed water was supplied to the boiler at a temperature of 198° and that 85 per cent of the heat of the coal was imparted to the water, it would require one pound of coal per hour to generate 12 lbs. of steam at a gauge pressure of 150 lbs., so that we should be obtaining a horse-power with one pound of coal an hour, which is a most excellent result. On the basis of reckoning from the total potential energy of the coal, however, the efficiency of the boiler and engine would only be

$$\frac{1{,}980{,}000 \times 100}{11{,}281{,}000} = 17.5 \text{ per cent,}$$

whereas we are entitled to claim 68 per cent, as shown by the numerical example above.

Abstracts from Foreign Contemporaries

Magnetic Blow-out for Railway Controllers.—In an article contributed to the "Elektrotechnische Zeitschrift" on the control of railway motors, Herr K. Sieber describes a magnetic blow-out designed and used by him, and attached as shown by Fig. 1. The contact arm, originally constructed as shown by Fig. 2, is replaced by a magnet, through the windings of which the current conveyed to the laminations must first pass. In order to close the magnetic circuit, iron plates are placed under the laminations. The lines of force being concentrated at the points where they are required, but a few turns are needed in order to secure a powerful action. Only part of the contact arm is arranged for spark extinguishing.

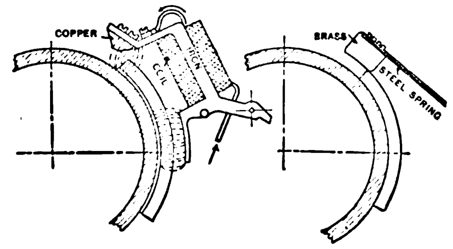


FIG. 1.—MAGNETIC BLOW-OUT--FIG. 2.

Avoiding No-Load Loss in Transformers.—The accompanying illustration taken from a recent issue of the "Zeitschrift fuer Elektrotechnik" depicts a simple method devised by M. Osnos for cutting in and out of circuit transformers supplying motors, the method being to switch out the primary winding of the transformer; the no-load loss in the transformer is consequently avoided. In Fig. 3 M is an alternating-current motor, PP, are the terminals of the high-tension supply circuit, B is a battery, U is a switch, S is a coil with an iron core, K, and R and R_1 are non-inductive resistances. To connect the motor to the circuit, the switch U is placed on contact, 2. A current from the battery traverses the solenoid, S, magnetizing the iron core, causing it to attract the iron shoulder of the lever, L. This releases the core which drops of its own weight, engaging the lever, l, which switches in the primary winding. The motor now running, the switch may be returned to its middle position. To throw the motor out of circuit, the switch is placed on contact, 1, whereupon an alternating current from the secondary of the transformer traverses the solenoid causing it to lift the iron core. This in its upward motion engages the lever, l, which opens the circuit through the primary winding. The core then drops to the position shown in the engraving, where it is held by the lever, L. It is evident that the arrangement may be also applied to a direct-current motor and that the switch, l, may be double-pole instead of single, as shown in the engraving.

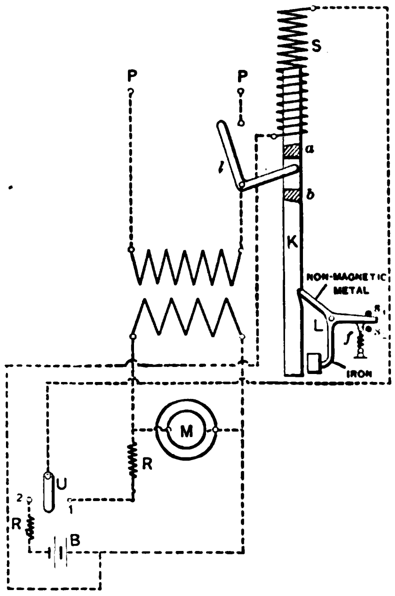


FIG. 3.—TRANSFORMER CONNECTIONS.

Testing Alternating Current Meters on Artificial Loads.—It is usually desirable when testing instruments for the measurement of large amounts of energy to do so by means of artificial loads. While this is a comparatively easy matter with direct currents, in alternating-current work there is encountered the difficulty of keeping the current and e.m.f. in phase with each other. Albert Campbell, in the London "Electrician," describes the arrangement shown by Fig. 4, which he has found convenient for this purpose. Suppose, for example, the artificial load required is 500 amperes at 100 volts. A transformer, T, with its primary supplied at 100 volts, delivers at its secondary 500 amperes at 5 or 6 volts. Connected in series on the secondary circuit are the series coil of the instrument, M, under test, an ammeter, A, and a non-inductive resistance, R, which will pass 500 amperes at about 5 volts. The low-pressure coil of a closed iron-circuit transformer, t, of a ratio of 1:20 is connected to suitable points of this resistance. The high-pressure coil of this transformer furnishes the e.m.f. required for the shunt coil of the instrument being tested. It will be found that the e.m.f. is practically in phase with the current of 500 amperes.

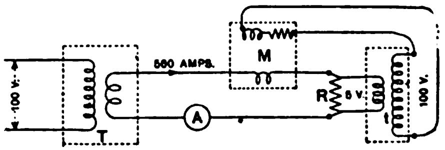


FIG. 4.—ALTERNATING-CURRENT METER TEST.

Pole Finders.—It is oftentimes necessary, especially in charging accumulators, to determine the poles of the circuit used. Aside from using deflecting electrical instruments or pocket compass, the "Elektrotechnischer Anzeiger" gives a number of other methods. Wilkes' reagent paper and the ordinary litmus paper will determine the poles when the difference of potential is as low as 1 volt; Wilkes' reagent paper giving a red spot at the negative terminal, while litmus paper gives a red spot at the positive terminal. Paper moistened with a solution of iodic arsenite of potassium yields a black color at the positive terminal. Berghausen's pole-seeker consists of a solution of phenol phthalein and chloride of sodium or sodium sulphate which gives a red color at the negative terminal; the color vanishing when the current is off. When lead electrodes are used in dilute sulphuric acid, the positive electrode becomes dark brown, owing to the formation of a peroxide, while with copper electrodes a violent evolution of gas takes place at the positive electrode. In a solution of common salt the positive copper electrode imparts a green color to the solution, the plate itself becoming somewhat reddened.

Method of Measuring Power in Alternating-Current Circuits.—The three-volt meter method of measuring power, although convenient and accurate, is not altogether free from error, especially if but one voltmeter be used; and the auxiliary non-inductive resistance is usually so large that a considerable fraction of the total available voltage is lost. In a method described by Albert Campbell in a recent number of the London "Electrician," this difficulty is entirely eliminated, not more than 1 per cent of the available voltage being lost. The connections are shown in Fig. 5. A is the circuit the power of which is to be measured. It is connected in series with a small non-inductive resistance, r, across the supply circuit. The small difference of potential between the terminals of r is raised by a small transformer, N, having a high ratio of transformation; which ratio must be sufficient to make the primary current negligible in comparison with the current in A. The power phase of the e.m.f., V., will be practically 180° behind that of U. By means of the reversing switch, H, and the electrostatic voltmeter, D, the effective resultants of e.m.f., x, and the e.m.f., V, with the latter reversed and direct, can be obtained.

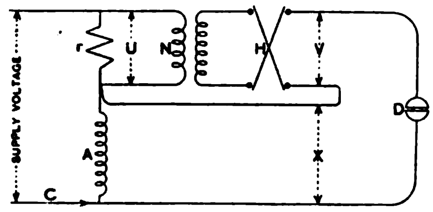


FIG. 5.—DIAGRAM OF CONNECTIONS.

Alternating Current Watt-hour Meter.—What purports to be one of the cheapest and simplest meters for alternating currents is described in a recent issue of the London "Electrical Review." It consists of a revolving disc, A (Fig. 8), subjected to the action of two alternating magnetic fields, differing in phase, which impress a driving force upon it. Potential coils, S, S_2, and a main current bobbin, H (Fig. 9), are placed at one side of the disc, their cores being connected to a single yoke, E, and the magnetic circuit completed by a single armature, R. In operation the shunt bobbins, S, S_2, impart a moderately strong turning movement to the disc which is utilized in overcoming the friction of the apparatus by adjusting the air space, L, L_2. When the main current is turned on, a mutual action takes place between the magnetic field of the main current and the vortex currents generated in the disc by the shunt bobbins on the one hand, and between the magnetic fields of the shunt bobbins and the vortex currents generated by the main current bobbin on the other hand, resulting in the rotation of the disc. To prevent the field of the main current bobbin acting upon the fields of the shunt bobbins, a part of the main current circuit is wound about one of the shunt cores as shown in Fig. 9. The speed of rotation imparted to the disc is directly proportional to the product of the current and the pressure, and is transmitted to a counting mechanism by worm gearing, the magnet, M, acting as a brake to the disc. The reading is in kilowatt-hours and is shown in a single row of figures on the face of the meter. No reduction is necessary, since the constant of the instrument is always unity.

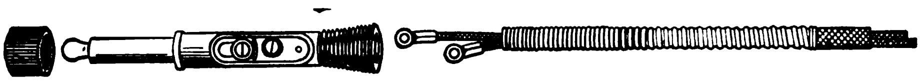


FIG. 6.—TELEPHONE CIRCUIT PLUG.—FIG. 7.

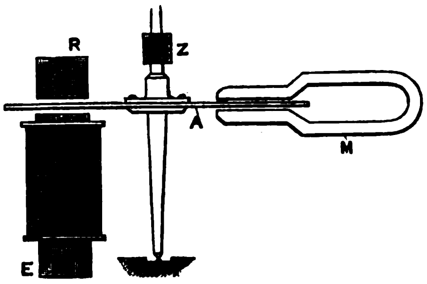


FIG. 8.—DISC AND MAGNETS.

A New Circuit Plug.—A recent number of the "Elektrotechnischer Anzeiger" contains a description of a new circuit plug illustrated herewith. The wires are double cotton covered each wound separately with different colored silk in order to differentiate the poles. Both are then wound with glazed yarn and are further strengthened by a winding of thin whipcord, or gut-string. Contacts are soldered on the ends as shown in Fig. 7. The cord is then passed into the circuit plug and the terminals securely fastened by screws as shown in Fig. 6. The small chuck at the right firmly clamps the cord for some distance, and together with the screwed contacts renders less liable ruptured plugs resulting from rough usage.

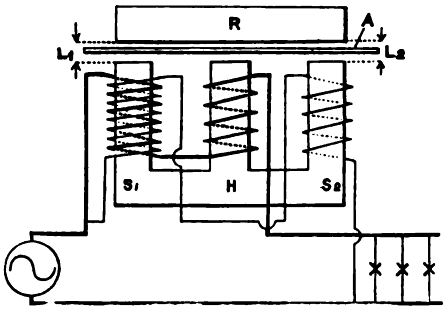


FIG. 9.—DIAGRAM OF WINDINGS.

Commercial Nernst Lamps.—The London "Electrical Review" has described some commercial forms of Nernst lamps as they are being made by the Nernst Electric Light Company, Ltd., of Great Britain. Fig. 10 shows a 16-c.p. lamp designed to be lighted by heat applied from the outside through a hole in the bottom of the globe, and Fig. 11 shows the interior parts of this lamp. The top of the lamp consists of a brass cap with a bayonet lock for holding the globe in position. This cap contains two metal hooks to which the leading-in wires are attached. The glow rod or burner is suspended from a porcelain block by means of nickel connecting wires. The series-resistance coil which is used to compensate for the negative-temperature coefficient of the glow rod, consists of a very fine platinum wire wound on a triangular piece of porcelain and suspended just below the porcelain block. The two contact strips projecting above the upper side of the block constitute the terminals of the arrangement, and these hang from the hook terminals within the brass cap. Fig. 12 shows an automatic 16-c.p. lamp, and Fig. 13 shows diagrammatically the arrangement of the parts of this lamp. A heating coil is em-

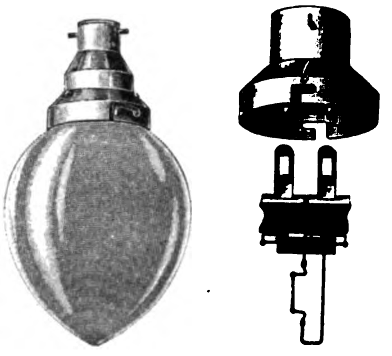


FIG. 10.—16-C.P. NERNST LAMP.—FIG. 11.

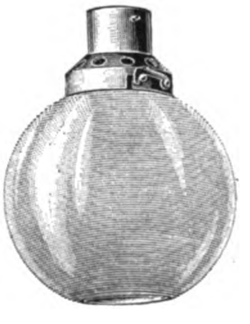


FIG. 12.

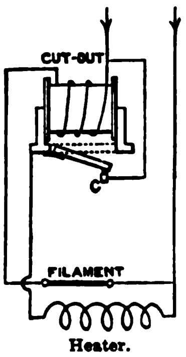


FIG. 13.

ployed, which is mounted below the glow rod, and is cut out of circuit by the relay as soon as current begins to flow through the glow rod. The relay is mounted in the top of the lamp or socket. The life of the glow rod is said to be about 500 hours, and the efficiency slowly falls from 1.7 to 2 watts per candle. When used on direct-current circuits, the positive end of the glow rod tends to get excessively hot, and in order to prevent this the platinum connections at each end of the glow rod have been made with a little star-shaped piece which provides a radiating surface and keeps down the temperature. These lamps are standardized for 8, 16, 32 and other candle-powers, to operate on circuits of 100 volts and upward.

Test of a Large Gas Engine Using Producer Glass.—An elaborate paper which was read recently by Mr. Herbert A. Humphrey before the British Institution of Mechanical Engineers included some important records of gas-engine trials using producer gas made from cheap fuel by the Mond process. The fuel used in the manufacture of the gas was bituminous slack containing 62.69 per cent of carbon and having a calorific value of 12,215 B. T. U. per pound of dry fuel. This coal produced 59.2 cu. ft. of dry gas (at 32° Fahr.) per pound of fuel, and the calorific value of the gas was 158.8 B. T. U. per cubic foot at that temperature. Fig. 14 is a diagram of the apparatus. The Mond process consists broadly of feeding the bituminous slack into a bell or retort at the top of the producer, where it is first heated. The products of distillation pass downward into the hot zone of fuel before joining the bulk of the gas leaving the producer; this destroys the tar and converts it into a fixed gas, and also prepares the slack for its descent into the body of the producer, where it is acted upon by an air blast saturated with steam at 185° Fahr., and is thus superheated before coming into actual contact with the fuel. The quantity of steam introduced into the air blast is relatively large, amounting to 2½ lbs. for each pound of fuel gasified. Half a pound of steam is decomposed in the producer for each pound of fuel burnt, thereby yielding free hydrogen to the extent of 29 per cent (by volume) in the fuel gas.

The hot gas and undecomposed steam leaving the producer, pass first through a regenerator in the opposite direction to the incoming blast, thereby delivering heat to the air blast. The blast is still further heated by passing down an annular space between the two shells of the producer on its way to the grate. The hot products from the producer are passed through a washer which cools the steam and gas down to about 194° Fahr., and by the formation of more steam, tending to saturate the gas with water vapor at this time, the bulk of the sensible heat is converted into latent heat. The producer gas then passes upward through a lead-lined tower filled with tiles, in which it meets a downward flow of acid liquor containing sulphate of ammonia, with about 4 per cent excess of free sulphuric acid. Combination of the ammonia of the gas with the free acid takes place, furnishing still more sulphate of ammonia, so that in order to make the process continuous some sulphate liquor is constantly withdrawn from circulation and evaporated to yield solid sulphate of ammonia, and some free acid is constantly added to the liquor, which is circulated through the tower by means of pumps. The gas having delivered this ammonia, is conducted to a cooling tower, where it meets a downward flow of cold water which cools and cleans it before it passes to the various furnaces and engines in which it is used. The cooling of the gas and steam results in the condensation of the latter, and in the elevation of the temperature of the cooling water, of course, so that the latter leaves the tower as hot water. It is utilized in a third tower, called the air-heating tower, through which the air blast for the producer passes. It is stated that utilizing the heat of the gas in this manner adds nearly a pound of steam to the producer blast for each pound of fuel gasified, and forms one of the distinctive features in the economy of the plant. This water which performs the double duty of cooling the gas and heating the air blast is circulated constantly through the two towers by pumps. Both towers are filled with tiles in order to give large areas of contact surface.

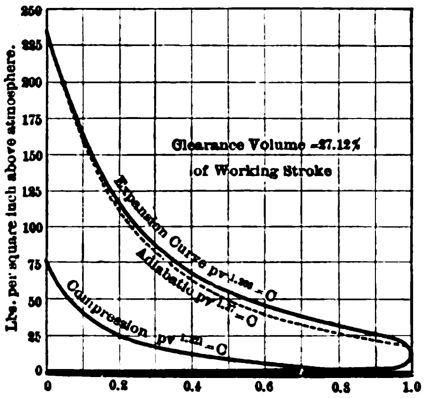


FIG. 15.—INDICATOR DIAGRAM.

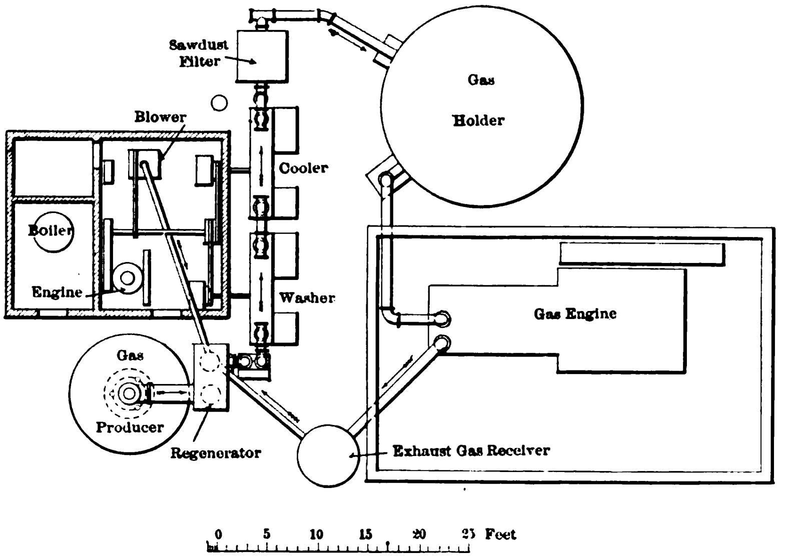


FIG. 14.—DIAGRAM OF PRODUCER GAS PLANT.

Producer gas made by the Mond process just outlined requires 1.15 volumes of air for perfect combustion. The gas has a specific gravity of 0.7882; a specific heat at constant pressure of 0.3201, and a specific heat at constant volume of 0.2321. The specific heat at constant pressure of the products of combustion is 0.2622, and the specific heat at constant volume of the product is 0.1922. A test of a 400-h.p. Crossley double-cylinder engine driving a dynamo and using gas made by this process having a calorific value of only 90 B. T. U. per cubic foot, showed a consumption of 60 cu. ft. per hour per indicated horse-power. The mechanical efficiency of the engine was 83 per cent, and the overall efficiency of the dynamo was 93 per cent, so that the gas used per kilowatt-hour was 104.3 cu. ft. reduced to the basis of 32° Fahr. The thermal efficiency of the engine was 26.23 per cent, calculated on the basis of indicated horse-power, or 21.78 per cent on the basis of the horse-power delivered to the dynamo. Fig. 15 herewith shows an average of the indicator diagrams taken from this engine during a test of six hours. As the diagram plainly shows, the expansion curve actually obtained was slightly higher than the theoretical adiabatic curve, but in the main did not depart greatly from the theoretical curve. The author stated that the cost of fuel per unit of power developed by the use of the Mond gas process in large gas engines was approximately 23 per cent of the cost of fuel per unit of power for a steam plant, based on ideal conditions of economy, and slightly less than 12½ per cent of the cost of fuel for steam plants based on data taken from 83 principal electrical stations in Great Britain for the year 1898.

The Measurement of Steam Delivery—A discussion of a direct system measuring both the quality of steam delivered in a given time and the rate of delivery at any instant by means of a Gehre steam meter is the subject of an article by Herr L. C. Wolff in a recent issue of the "Zeitschrift des Vereines Deutscher Ingenieure." The Gehre meter, it might be said by way of explanation, has for its principle the drop in pressure caused by a flow of steam through a contracted aperture. The simplest means of computing the velocity of flow under these conditions heretofore was by Napier's law from which the weight of steam discharged per second through a given opening may be found. To obviate any arithmetical operations the meter has a mechanical device by means of which the weight of steam can be determined by examining a recorded diagram. The position of the recording point gives the rate of flow at the moment of observation, while the total delivery of steam in an extended period is obtained by measuring the area of the recorded diagram, the same as one would measure the area of a steam indicator diagram. The accuracy of the readings were tested by repeated measurements of volumes of steam, condensed and weighed, and the error of the apparatus was found to be less than 1 per cent.

Some Recent Electrical Patents

Motor-Starting Rheostat.—In almost all modern motor-starting rheostats there are provided two distinct automatic devices, the function of one being to release the rheostat arm in case the current supply fails, and allow the arm to be returned to zero by its spring, and the function of the other being that of an ordinary circuit-breaker, namely, to open the circuit in case the motor becomes seriously overloaded. Fig. 1 represents a rheostat devised by E. M. Hewlett in which both of these functions are discharged by a single mechanism. The no-load release magnet, E, is provided with the usual pole pieces, which hold the armature, E², of the rheostat arm as long as the current passes through the winding. The core of the magnet, however, instead of being of the ordinary fixed type is divided into two parts, a stationary plug, e¹, and a plunger core, F, which has a limited range of movement. This latter core, in conjunction with the winding, constitutes the overload relay; on its outer end is carried a contact strip, I, which, when the current becomes too heavy, is drawn up against the contact posts, G, G. Connections from these posts lead to the terminals of the winding, E, so that the strip, I, short-circuits that winding, the result being the release of the armature, E², allowing the rheostat arm to be thrown to the "off" position. The winding, E, of the magnet, instead of being connected in series with the field winding of the motor as is usually the case, is connected in series with the armature. At first thought this might seem to be a defect as it seemingly fails to provide for the release of the rheostat arm in case the field circuit of the motor is broken while the armature circuit remains intact. In such a case, however, it is plain that the breaking of the field magnet circuit would result in overloading the armature, so that the plunger, F, would be immediately drawn in, short-circuiting the magnet winding and releasing the rheostat arm. Patent No. 664,087.

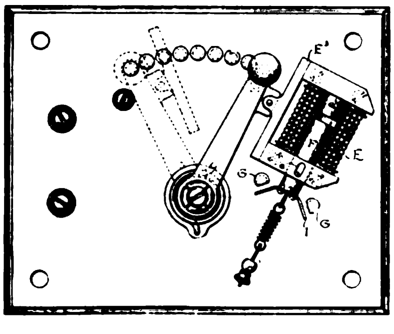


FIG. 1.—RHEOSTAT.

Telephone Transmitter.—Fig. 2 illustrates a peculiar form of carbon contact for use in a telephone transmitter which has been patented by August H. Skold, the object of the inventor being to eliminate the induction coil used for intensifying the action of the ordinary transmitter. The carbon contacts are in two pieces, a circular central plug, C^1, constituting one terminal, and the segment, C^6, of the surrounding block constituting the other terminal of the circuit. The ring of granular carbon surrounding the central plug is cut entirely through between the segments, C^3 and C^4, but is only slit down about two-thirds of its thickness between C^4 and C^5, C^2 and C^6, and C^2 and C^3. The transmitter diaphragm carries three connecting strips of tinfoil, as shown in Fig. 2. The relation between the carbon contacts and the diaphragm is such that the piece of tinfoil, p^1, which is insulated from the diaphragm, connects the face of the central button, C^1, with the carbon segment, C^2. The tinfoil segment, p^2, which is also insulated from the diaphragm, connects the faces of the segments, C^3 and C^4, and the tinfoil segment, p^3, which is not insulated from the diaphragm, forms a connection between the latter and the face of the segment, C^5. This arrangement gives five points of contact, all in series, and the claim is that the effect of the transmitter diaphragm is intensified fivefold by this arrangement. The path of the current is from the button, C^1, to the tinfoil segment, p^1; thence to the segment, C^2; down through the lower part of the carbon ring to the segment, C^3; thence by way of the tinfoil segment, p^2, over to the carbon segment, C^4; thence down through the lower part of the carbon ring again to the segment, C^5, and from the face of that segment to the tinfoil segment, p^3, which is electrically connected with the other terminal of the battery through the diaphragm, D. Patent No. 664,904.

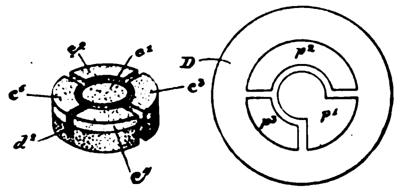


FIG. 2.—CARBON CONTACTS.

Enclosed Fuse.—When safety fuses are entirely enclosed by an insulating casing, it is usually impossible to tell by an inspection of the exterior of the casing whether the fuse has blown or not. This has led to the practice of providing auxiliary fuses of a smaller carrying capacity than the main fuse and connected in parallel with it. Fig. 3 herewith illustrates an arrangement of this sort which has been patented by Otto Feuerlein. The feature of this arrangement is that the two fuses are mounted in one cylindrical casing but are separated by a partition wall of insulating material, so that the main fuse, *d*, is entirely enclosed while the supplementary fuse, *f*, is visible through the opening, *c*. Another feature of the arrangement is that the fuse, *f*, is so proportioned that a current flowing from one terminal plate, *e*, to the other over the parallel path supplied by the two fuses will divide between the two fuses in such proportion as that the limiting capacity of the main fuse will be reached before that of the auxiliary fuse, thus insuring the melting of the main fuse. If the characteristics of the two fuses were identical, one would be just as likely to go first as the other, as the current would divide between them approximately in proportion to their carrying capacities, and the condition of the main fuse would not necessarily be indicated by that of the auxiliary fuse. Patent No. 661,241.

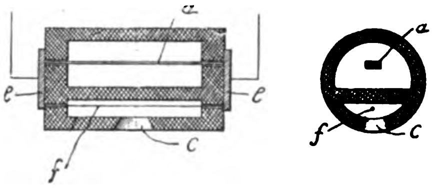


FIG. 3.—ENCLOSED FUSE.

Brush-Holder.—Much effort has been devoted toward the production of a holder for carbon brushes which shall fulfill the requirements of compactness, reliable contact and positive feeding. A recent form of brush-holder devised with these requirements in view has been patented by Christian W. Kragh, and is illustrated by Fig. 4 herewith. The brush-holder, B, consists of a slotted block through which the brush, A, slides in the ordinary manner. Permanent contact between the brush and the holder is obtained by the use of the flexible strip, D.

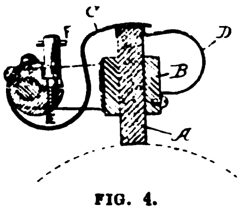


FIG. 4.

The brush is forced toward the commutator by means of flat springs, C, the tension of which is adjustable by twisting the collar, E, about the brush-holder rod. The collar is clamped by means of the screw, F. Patent No. 664,649.

Commutator.—One of the drawbacks inherent in the operation of modern commutators is the wearing away of the copper commutator segments at a greater rate than the mica insulating strips are worn away, the result being that the strips eventually project slightly beyond the level of the copper segments and cause the brushes to chatter and spark. A method for eliminating this trouble has been patented by E. D. Priest and George L. Schermerhorn, and consists of using strips of mica which are not quite as wide as the copper segments, so that the edges of the mica strips are not quite flush with the brush tread of the copper segments. Patent No. 662,465.

NEW BOOKS.

Twenty-Third Convention of the National Electric Light Association. Published by the Association. Cloth; 460 pages, 6 x 9 ins.

This book contains the complete proceedings of the twenty-third convention of the association which was held in Chicago last May, including all of the extremely interesting papers which were read at that convention.

Report of the Fifth Annual Convention of the International Association of Municipal Electricians. Published by the Association. Flexible leather; 204 pages, 6 x 9 ins.

This is a well-executed record of the proceedings of the convention held in Pittsburg last September, and opens a brief history of the association. The proceedings of the fifth annual convention are given in full, and contain much information of practical value to municipal electricians, and operating engineers also.

Design and Construction of Oil Engines. By A. H. Goldingham. New York: Spon & Chamberlain. Cloth; 196 pages 5 x 7½ ins.; 79 illustrations. Price, $2.

This book has all the ear marks of a compilation at the hands of a smatterer. Among the bits of definite wisdom in the chapter on design is this: "The circulating-water space around the cylinder is made ¾ in. to 1½ ins. deep, the water inlet and outer pipes being so arranged as to allow free and efficient circulation of the cooling water around the cylinder." That's all. Again: "The cylinder clearance allowed will depend upon the pressure of compression as determined by experiment and by the indicator diagram, producing properly timed ignition and combustion." One naturally pauses to ask how on earth one is to get an indicator diagram from an engine not yet designed. And that sciolistic gibberish about ignition and combustion—what purpose it serves is difficult to conceive. On the subject of shafts the author waxes prolific in data, having stumbled upon William Norris' formula (which he has the nauseating impudence to "recommend"!) and table of dimensions. The book is puerile and amateurish, the small amount of definite data which it contains having been apparently copied from various sources available to everyone.

Machinists' and Draftsmen's Handbook. By P. Lobben. New York: D. Van Nostrand Company. Cloth; 438 pages 5 x 7½ ins. Price, $2.50.

This is a most convenient reference book, containing formulas, tables and rules applying to mechanical engineering generally. Among the many commendable features are trigonometrical formulas of a practical value and not usually found in handbooks; an excellent and comprehensive chapter on Strength of Materials, and one on power transmitting mediums—shafting, belting, gears, etc. The hydraulic formulas are rather empirical and are not reduced to their simplest form, but they serve well enough for approximate calculations. The book is of value not only to machinists and draftsmen but to all classes of engineers.

NOTES.

Sparking Dynamo Winding. — In the description of the small sparking dynamo for gas engine service which was published last month, it was stated that the armature winding for 32 volts consisted of "16 coils of No. 22 wire"; this should have read "16 coils of No. 28 wire."

Atlanta Independent Telephone Exchange.—In the article descriptive of this interesting exchange published in our January number credit should have been given to Col. John W. Rutherfoord and H. A. Douglass, of the Atlanta Standard Construction Company, who had charge of the line construction of the plant.

Telephone Extensions in Italy.—The Italian Board of Public Works has approved of an important project for placing the various railway stations of the Mediterranean, Adriatic and Sicilian companies in touch with one another by means of the telephone. The exchange will be in Rome, and the project is to be put in execution this year.

National Electric Light Convention. — The twenty-fourth convention of the National Electric Light Association will be held May 21 to 23 inclusive at Niagara Falls. The headquarters of the delegates will be at the International Hotel. Full information regarding train schedules, special rates, etc., may be had from Mr. Geo. F. Porter, secretary of the Association. The secretary's office is at 136 Liberty Street, New York.

Water Power Development in Spain.—The Sociedad di Approvechamiento del Rio Gallego is the name of a company that has been formed at Saragossa, Spain, for the utilization of two waterfalls situated on the River Gallego. The first is in the Province of Puendeluno and is calculated to develop 3200 horse-power, the second is in Murillo, and is estimated to yield 2600 horse-power. Both courses are within 30 miles of Saragossa.

Lowering Arc Lamps in a Public Street.—A recent decision of the Second Appellate Division of the Supreme Court of New York vindicated the practice by electric light companies of lowering arc lamps in the streets for trimming. A suit was brought by a bicycle rider who came into collision with an arc lamp on one of the streets of Yonkers just as the lamp was lowered for the purpose of trimming. Judgment was given to the plaintiff in a lower court, and this judgment was reversed by the supreme court, which in its opinion stated that there was no presumption of negligence on the part of the electric light company by reason of an employee having lowered a lamp for giving it attention.

Electric Traction in Australia.—The old steam-tramway lines in Sydney are being rapidly displaced by an overhead-trolley system. The opening of the latest section of these railways was recently celebrated by the Electrical Association of New South Wales in a characteristically colonial fashion by a trolley-car party. A line, backed by private capital, has also been established between Rockdale and Lady Robinson's Beach. The plant for this line is thoroughly modern, consisting of Willans high-speed engines direct-connected to Siemens generators; Babcock & Wilcox boilers fed by motor-driven pumps, and an auxiliary battery of Chloride accumulators. In Melbourne, notwithstanding the success of the cable system, the suburban authorities are urging the construction of a trolley line to connect the suburbs with each other direct, the cable system being entirely a radial one. Messrs. Callender and the Westinghouse Company have a bill before Parliament asking for the power to convert some 50 miles of present horse-car lines into electric lines, and the suburban authorities are also working with the same end in view.

An Important Patent Decision. —The suit brought by the American Bell Telephone Company against the National Telephone Manufacturing Company, the Century Telephone Company and others, to restrain the respondents from the manufacture, sale or use of telephone apparatus including a microphone form of transmitter, was decided against the Bell Company on February 27 by Judge Brown of the United States Circuit Court, sitting in Boston. The patent involved is the one issued in 1891 to Berliner, which was considered one of the most important of the fundamental patents held by the Bell Company. The decision of the court holds that the Berliner patent is invalid; first, because at the date of the application for the patent Berliner had not made the invention covered by the patent; second, because the invention described in the patent is radically different from that described in the application; third, because the invention was previously patented by Berliner in 1880; and fourth, because Edison was the prior inventor. The rescript compares the work of Berliner with that of Edison at considerable length, the argument being that the world owes the modern transmitter to Edison and not to Berliner. The case will doubtless be appealed.

An American Institute Conversazione.—Encouraged by what has been accomplished by other technical societies, and what they have recently seen abroad, the Council and Committee on Meetings of the American Institute of Electrical Engineers have arranged for a conversazione to be given by that body some time in April. Through the courtesy of Columbia University, the conversazione will be held in the Electrical Engineering Department, with the co-operation of Prof. Crocker, Dr. Pupin, Mr. G. F. Sever and others of the staff there, and so much interest has already been shown in the matter that a brilliant success is forecast. While the conversazione will be largely social in character, a special feature will be the exhibition of latest electrical apparatus, inventions, etc., in working condition. Mr. Edison, Prof. Elihu Thomson, Dr. Pupin and others have promised personal assistance in this respect. Secretary Pope and Mr. W. S. Barstow, chairman of the Papers and Meetings Committee, extend through the press an invitation to all members to contribute features of scientific interest and to give an early notification of what they will do in this respect.

A Mysterious Current.—A very peculiar phenomenon has been observed in connection with the 1500-kw. alternators at the big Snoqualmie Falls plant, near Seattle, Wash. The generators are three-phase machines of the revolving armature type, giving 1000 volts and 1500 amperes, and running at 300 r.p.m. They are direct-connected to impact water wheels. There is a difference of potential between the end of the armature shaft and the journal box sufficient to maintain a short arc between the shaft and the free end of a wire connected to the journal box at its other end. There is evidently a heavy flow of current from the shaft to the box, and the thin film of oil between the shaft and bearing offers some resistance to this flow, so that there is an appreciable difference of potential between the shaft and the bearing. The effect is not only curious, but sometimes troublesome. There is enough sparking around the oil ring at times to burn and blacken the oil, and the bearing spits oil all over the surroundings. A contact brush bearing on the shaft obviates this, but it frequently becomes very hot from the passage of current through it. The flow of current seems to be proportional to the load on the machine. The armature and fields are perfectly free from grounds and of high insulation resistance.

Electric Light Plant Projected in Bucharest.—The "Compagnie du Gaz de Bucharest," whose headquarters are at Paris (Boulevard Haussmann) are at present in treaty with the communal administration of the Roumanian capital for a 40 years' concession for the lighting of the city. The municipal council propose to replace the gas lamps in the town by electricity and the oil lamps of the suburbs by gas. The concessionaires would be granted an exclusive right for the laying of electric cables in the town for lighting and motive power. Exception is made, however, in the case of conduits for electric traction. The offers of the gas company have received favorable consideration but still await the approbation of the Chamber. In case of acceptance, which seems probable, the construction of an important electric-power station would be immediately commenced.

M. Zenobe Theophile Gramme, who is known the world over by reason of his invention of the well-known ring armature winding, died at his residence in Bois Colombes, near Paris, on January 20. M. Gramme was born at Jehay-Bodignée, near Liege, Belgium, in 1826, and was in his youth a carpenter. Having a natural predilection, however, for mechanical and scientific subjects, he attended a course of lectures at Liege and afterward went to Paris, where he obtained employment as a pattern-maker in the factory where the old Alliance dynamo was made. Later on he worked under Ruhmkorff, and up to the time of his invention of the ring winding he followed the occupation of a machinist. The rapid commercial success of the Gramme dynamo is ascribed by Prof. Silvanus P. Thompson to the fact that it was the first practical machine in which were combined the features of continuity of commutation, self-excited fields, proper lamination of the armature core and reasonably good proportions in the magnetic circuit. Gramme exhibited his machine at every exposition that was held up to about 1881, and received many honors on account of his invention. The French Government awarded him a prize of 20,000 francs, and the Academy of Sciences gave him the Volta prize, which carried with it the same amount of money. He was also decorated by the French and several other European governments.

THE LATE Z. T. GRAMME.

In 1877-78 he designed and built a number of alternating-current machines for supplying current to Jablochkoff candles. The field magnet of these machines rotated; the armature was stationary and was so wound that a different number of circuits could be led from it, according to the manner in which it was connected up. Gramme retained his connection with the company originally organized to manufacture his apparatus, the Société Gramme, up to the end of his life, although recently this connection was merely a nominal one. M. Bollinckx, the well-known Belgian engine builder, informs us that Gramme was often asked to take out naturalization papers in France, but steadfastly refused, preferring to remain a Belgian subject. There is a street in Liege which bears his name.

Wiring for the Pan-American Exposition.—Mr. Henry Rustin, chief of the Mechanical and Electrical Bureau of the Pan-American Exposition to be held this summer at Buffalo, states that the wiring of the grounds and various buildings of the Exposition has progressed satisfactorily. The two restaurants are complete in their wiring and are ready for the lamps. Machinery Building is complete, so far as the wiring is concerned, and half of the lamps are in place. A test of the illumination of this building has been made, and is reported as highly satisfactory. The group of three buildings, Mines, Horticulture and Graphic Arts, is complete with the exception of the upper portion of the main dome. The three buildings of the Government group are also complete with the exception of the center dome of the main building. Electricity Building and Agricultural Building have been completed and are ready to light up. The Ethnology Building, the Temple of Music and the Manufacturers' Building have been completed so far as the staff work will allow attachment of lamp sockets. At every point, the electricians are following the staff workers as rapidly as possible. On the Electric Tower a large force of men is keeping up with the construction work, and the structure is being brought rapidly to a state of completion.

In the courts and canals, in fact all the open areas, a vast amount of underground wire is being laid to serve the lighting posts, each of which will have from 26 to 100 incandescent lamps. The number of incandescent lamps to be used in the exterior lighting effects has been estimated at 200,000, but the fact is that the number will be over 500,000.

ESTABLISHED 1889.

American Electrician,

WITH WHICH IS INCORPORATED
Electrical Industries.

CECIL P. POOLE, Editor.

Published on the first of each month by the

American Electrician Company,

NEW YORK: 120 Liberty Street.
CHICAGO: Monadnock Block.
PHILADELPHIA: 929 Chestnut Street.

JAMES H. McGRAW, President.
A. E. CLIFFORD, Vice-President.
C. E. WHITTLESEY, Treasurer.
E. E. WOOD, Secretary.

Subscription, - $1.00 Per Year.
In the United States, Canada and Mexico.
FOREIGN COUNTRIES, $2.00.

NOTICE TO ADVERTISERS.

Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

IMPORTANT NOTICE.

Intending subscribers are warned not to place subscription orders with persons who cannot show written authority to take such subscriptions and make collections therefor, as the paper will not undertake to fill orders placed with alleged agents acting without such written authority.

Subscribers requesting a change of address should invariably furnish both the old and the new address.

Vol. XIII. MARCH, 1901. No. 3

The American Electrician has a larger paid subscription list than any other electrical journal in the world.

CONTENTS.

The Lamp Signal Branch Telephone Exchange at East Cleveland, Ohio, by George L. Burlingame 99
The Modern Horizontal Tubular Boiler 102
The Electrolytic Production of Soda and Chlorine, by Ernest Franke 104
Some of the Special Features of the Portland General Electric System 105
A Comparison of Dynamos with Surface-Wound and Slot-Wound Armatures, by P. M. Heldt 106
A Note on the Use of the Electro-Dynamometer, by Fred P. Woodbury 107
The New Engines for the Brooklyn Edison Plant 108
A Russian Engine for Electric Lighting Service 111
Steam Engine Efficiencies, by A. F. Nagle 113
Abstracts from Foreign Contemporaries .. 114
Some Recent Electrical Patents 117
New Books 118
Notes 118
Editorial 120
The Construction of an Intercommunicating Telephone Set 122
Repair Shop Notes, by Arthur B. Weeks .. 125
Interior Wiring, by Charles E. Knox 126
Common Battery Telephone Switchboard Systems, by W. S. Henry 128
An Unusual Condition, by E. C. Parham .. 129
Globe Valves and Trapped Water, by R. A. Douglass 130
Fly Wheel Accidents, by C. W. Obert 131
Lessons in Practical Electricity 132
Letters on Practical Subjects 134
Electrical Catechism 137
Queries and Answers 138
New Gang Lightning Arresters and Switchboard Drop 139
The "Solid" Telephone Receiver 139
Eureka Telephone Switchboard 140
Stroud Toll-Service Recorder 141
Clarke Automatic Telephone System 141
A New Shell-Type Transformer 142
New Apparatus and Appliances 143
Legal Notes .... Adv. 33
Personals .... Adv. 33
Trade Publications .... Adv. 34
Business News .... Adv. 35

The Berliner Patent.

The decision handed down a few days ago by Judge Brown, of the United States Circuit Court, in the Berliner patent suit appears to bring up one or two new points. Hitherto, the points at issue affecting the validity of the patent were whether the Berliner transmitter patent of 1891 was void by reason of the Berliner receiver patent of 1880 describing precisely the same apparatus, and whether the invention described in the 1891 patent was the invention described in the application or an entirely different invention introduced by an amendment more than two years after the patented invention had been in public use. Judge Brown declares the Berliner patent invalid on both of these points, and in addition maintains that it is invalid because at the date of his application, June 4, 1877, Berliner had not made the invention described in his patent and because he was antedated in actual discovery by Edison, although the date of Edison's application was later than that of Berliner's. If the present decision be sustained, there will remain only switchboard details as an important source of legal contention between the Bell and the independent companies.

Steam Engine Efficiency.

Much has been said and written on the subject of steam engine efficiency, and the fallacy of considering engine efficiency as identical with the efficiency of heat utilization has been pointed out in these columns more than once. Notwithstanding the frequency with which engine efficiency proper has been explained, however, there arises a calamity howler from time to time, burdened with a sense of the sinful inefficiency of the steam engine and feeling it incumbent upon him to enlighten the balance of the world as to the "one converter of energy that has remained practically unimproved," etc., so that it is scarcely possible to give too much explanation of the right sort.

On another page will be found set forth a method of considering steam engine efficiency which is different from the one usually employed, and which has the partial advantage of including in its formula an expression that is more familiar to the average steam engineer than are the thermodynamic formulas. Unfortunately, the method is inaccurate for the reason that it is based upon isothermal expansion, or, if you please, the hyperbolic curve corresponding to isothermal expansion, which is not by any means the ideal curve and therefore cannot rationally be considered a standard. If it is desirable at all to use the formula of any curve as the criterion of what steam should do in a cylinder, the adiabatic curve would be the one to use, as it represents ideal thermal conditions. This would convert Mr. Nagle's formula for the work theoretically obtainable from the steam into

$$W = 144 \left[\frac{10\,P}{R} - \frac{9\,P}{R^{1.111}} - p \right] R\,C\,S$$

which is not attractive to contemplate.

However, with all respect to Mr. Nagle's well-known and high ability, there seems to be no particular need to seek anything better than the comparatively simple method of figuring efficiency on the basis of temperature range. In order to extract all of the heat energy from a pound of steam it would have to be expanded until its temperature fell to 461° below zero, which would mean a range of T + 461°, T representing the temperature of the steam when expansion begins. This is, of course, impossible; steam ceases to expand when its temperature reaches that of the medium into which it is discharged—the condenser, in the case of a condensing engine, and the atmosphere, in that of a non-condensing engine. Indicating the temperature of the ultimate receptacle by *t*, the range of expansion will be $T - t$, instead of $T + 461$, which would be necessary in order to utilize all of the heat. Consequently, the proportion of the heat units in the steam actually available for work is $\frac{T - t}{461 + T}$, and if the engine converts 60 per cent of this proportion into work it has an efficiency of 60 per cent, even though $\frac{T - t}{461 + T}$ may be only one-tenth of the heat range.

If the heat units contained in a pound of steam at boiler pressure be represented by H, then there will be available for conversion into mechanical work $H \frac{T - t}{461 + T}$ heat units per pound of steam delivered to the engine. If the engine consumes S pounds of steam per horse-power-hour, the available heat units contained in that steam will evidently be $H\,S \frac{T - t}{461 + T}$. Now, a horse-power-hour is equal to 2545 B. T. U. (heat units); therefore the efficiency of an engine using S pounds of steam per horse-power-hour will be given by the formula

$$\frac{254{,}500\,(461 + T)}{H\,S\,(T - t)} = \text{Per cent efficiency,}$$

which is simpler of solution than the less accurate formula advocated by Mr. Nagle. In his article is given a numerical example based on an engine taking 12 pounds of steam at 150 pounds gauge pressure, expanding it 30 times and exhausting against 1 pound condenser back pressure. The temperature, T, of steam at 150 pounds is 365.6°, and a pound of it contains 1193.5 B. T. U. The condenser temperature, t, would be 102°; S = 12 and H = 1193.5; substituting these values in the above formula gives

$$\frac{254{,}500\ (461 + 365.6)}{1193.5 \times 12\ (365.6 - 102)} = 55.7 \text{ per cent}$$

instead of 60 per cent, as given by Mr. Nagle's formula.

Line Construction.

In the reading and discussion of one of the papers presented before the recent convention of the Northwestern Electrical Association there were brought out several points regarding pole-line construction which should be noted by all superintendents of moderate-sized central stations. Prominent among these was the importance of electrically separating the upper from the lower portions of guy-wires and arc-lamp hoisting cables by means of circuit-breaks, and positively grounding the lower portions. Had Mr. Burch felt disposed to go farther into details it is highly probable that he would have recommended the location of the guy-wire circuit-breaks or insulators in a horizontal plane 5 or 6 ft. below the bottom cross-arm of a pole. Locating the insulators below the level of the lowest cross-arm gives assurance that the portion of the guy-wire between the insulator and the ground will not be liable to accidental contact with any of the line wires; placing these insulators as far as 5 or 6 ft. below the cross-arm puts the grounded portion of the guy-wire out of reach of a lineman's legs while his body is hemmed in by live wires. Another point that is very frequently ignored, and which should always be observed, is that the upper end of a guy-wire should never be made fast to the pole above the lowest cross-arm or insulator bracket. The progress of a climber is sufficiently impeded by the line wires and cross-arm braces without carrying the guy-wires up into the same plane.

The recommendation to put cross-arms on the side of the pole opposite the direction of strain might reasonably have been accompanied by a hint as to the direction from which the heaviest strain comes. In "pulling up" a line the strain is in the direction of pull so far as the last arm to which the line was tied is concerned, and this arm bears the brunt of the pull. The way the cross-arm should go on the pole depends upon how the running part of the line is made fast for tying; if it is temporarily "hitched" to a pole while the taut part is being tied to the insulators, which should be the practice, then the worst strain is that due to the "pulling up," and each cross-arm should go on the side of the pole away from the pulling-up tackle. All terminal poles and corner poles should be double cross-armed, and where very heavy wires are carried, every pole should be so treated. In the case of high-tension lines from which taps are made, it should be the practice either to leave the two pins next to the pole free of wires or to use special cross-arms having a spacing of at least 24 ins., and preferably 30, between the two pins next to the pole on each side. The increased space thus provided for the lineman's body gives him vastly better working speed because of both the decreased risk of electrical injury and the greater freedom from mechanical interference by the inner line wires. Of course this consideration does not apply to feeder or other lines from which branches do not have to be tapped from time to time while the circuit is alive.

Magnet Windings.

It is probably safe to say that nine persons out of ten labor under the delusion that the individual convolutions of wire in each layer of a magnet coil "bed" themselves in the slight trough between the convolutions of the next layer beneath. An eminent English authority, in discussing dynamo field magnet coils, suggests an allowance of 10 per cent for this bedding of wires! Now, unless all layers are started from the same end of the coil, which is obviously impracticable, the crease or groove formed by the convexity of surface presented by individual convolutions of a layer is a right-handed spiral in one layer and a left-handed spiral in the next, and so on. It will be evident upon a little reflection that the convolutions of a right-handed spiral cannot bed between those of a left-handed spiral to any considerable extent—certainly not to such an extent as to affect the calculated depth of the winding, as the bedding will take place at irregular points and merely affect the circularity of the layer.

There is, of course, some difference between the depth in inches of a given number of layers and the length of coil in inches given by the same number of turns side by side. The adjacent turns, no matter how accurately they may be wound, are not forced into such intimate contact as are contiguous layers, which are drawn down hard by the tension on the wire. This results in compressing the insulation between layers while that between adjacent turns is about normal or a trifle thicker than normal, so that ten turns of wire will take up more space along the core than ten layers will occupy measured outward from the core. The difference between the calculated depth of a coil and its actual depth, assuming that the gross diameter of the insulated wire is accurately measured, rarely exceeds 2 per cent of the total calculated thickness or depth when the wire is of a substantial size, say any size larger than No. 18, B. & S. gauge. For smaller sizes of wire, especially those above No. 30, the work of calculating the coil depth is scarcely justified, as the wire is usually put on so irregularly and the co-efficient of insulation compression is so uncertain that the relation between the calculated and the actual depth of a large number of layers is variable, and therefore problematical.

The relation between the dimensions of a coil and its magnetizing power is also not so well understood as it might be by general readers. The length of a coil parallel with its core affects its magnetizing power practically not at all if the applied e.m.f. is constant; the magnetic effect of the coil upon its core depends entirely upon the size of the wire, the terminal e.m.f. and the mean length per turn of wire (total length of wire divided by the total number of turns). With a constant difference of potential at its terminals, the magnetizing power (ampere-turns) of a coil varies inversely as the mean length per turn is varied, the size of wire being unchanged. Thus, a given size of wire made into a coil having an average length of 24 ins. per turn will have only seven-eighths the magnetizing power of the same wire made into a coil having an average length per turn of 21 ins., the voltage being the same in both cases. The reason for this becomes clear upon a little analysis. A given total length of wire wound into a coil of a given mean diameter will make more convolutions than if wound to a larger diameter. The voltage being the same, the current will be the same, and the ampere-turns of the smaller coil will, therefore, be greater than those of the larger one. It may be stated, therefore, as a general proposition, that thin coils are more efficient than thick ones.

THE CONSTRUCTION OF AN INTERCOMMUNICATING TELEPHONE SET.

The accompanying sketches illustrate more or less diagrammatically the essential features of a simple intercommunicating telephone outfit which may be constructed by any student of average mechanical and electrical ability. It will be impossible, however, for an amateur, no matter how skilled, to obtain the same results in the construction of the transmitter and receiver as are obtained by manufacturers with full facilities for this class of work, for two reasons; first, because the proper quality of carbon and steel will be difficult to obtain; and second, because an amateur cannot have adequate facilities for properly treating the steel of the receiver magnet. The set here described, however, will give good results in interior service, constructed from materials which are available to any reader.

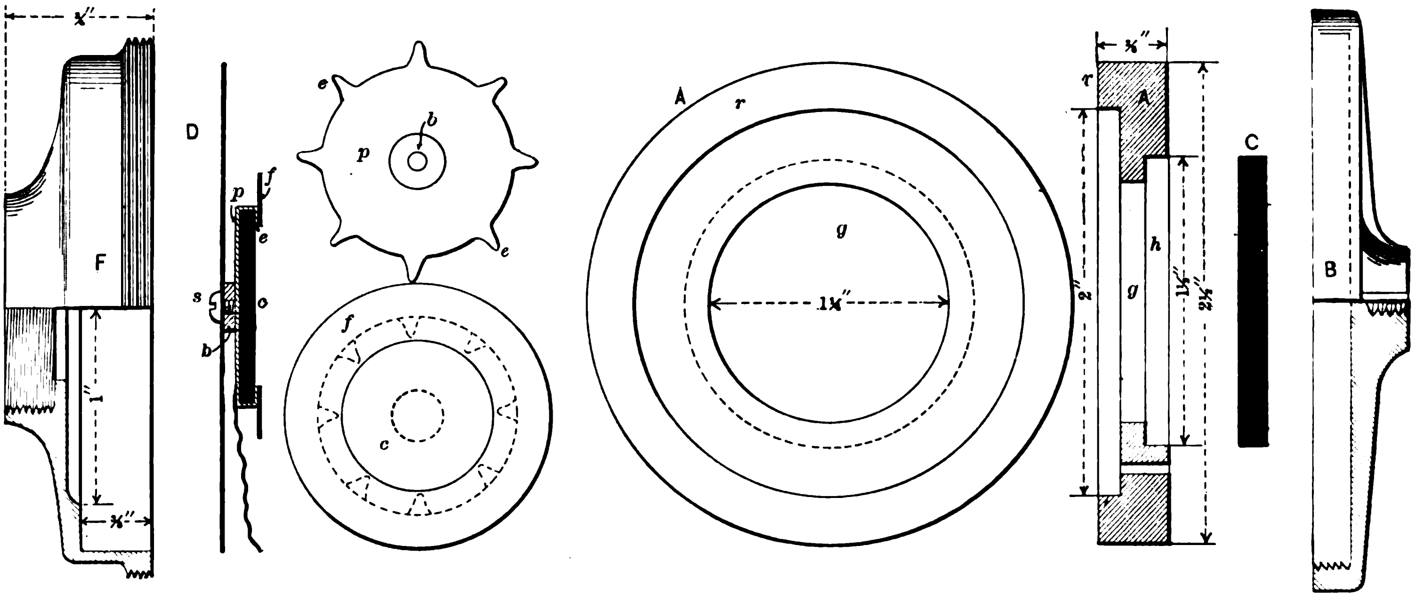


FIG. 1. FIG. 2. FIG. 3. FIG. 4. FIG. 5. FIG. 6.

DETAILS OF TELEPHONE TRANSMITTER.

The transmitter is illustrated by Figs. 1 to 9, inclusive. Fig. 1 is a semi-sectional view of the front cap or shell of the transmitter, which may be made of brass or any other metal. The outside diameter of the body portion is 2⅝ ins., and the diameter of the threaded portion is 2¾ ins.; the wall of the shell is 1/16 in. thick. The diameter of the mouth into which a rubber mouthpiece should be screwed, is ⅞ in., and the depth of the mouth-piece thread is ¼ in. The other important dimensions are marked on the sketch. The diaphragm and front electrode are shown in cross-section by Fig. 2. The diaphragm, D, consists of a disc of tin 2⅛ ins. in diameter and 0.012 in. thick. To the center of the diaphragm is secured the front electrode by means of the small brass screw, *s*, and a round nut, *b*. The electrode, *c*, is a disc of carbon 1 in. in diameter and 1/16 in. thick, mounted on a very thin brass plate, *p*, a front view of which is shown in the upper part of Fig. 3 with the retaining clips or ears, *e*, straightened out. These ears are bent over the rim of the carbon disc to hold it in place. The plate, *p*, is soldered to the nut, *b*. After mounting the carbon disc, *c*, on the plate and bending the ears over its edge, a ring of felt, *f*, 1½ ins. in diameter, with a ¾-in. hole through the center, should be glued to the electrode by means of shellac varnish, so that the metal ears or clips which lap over the carbon disc will be covered by the felt and prevented from coming into contact with the carbon granules when the transmitter is assembled. This felt ring also serves to hold the granules in the chamber, as shown in Fig. 9.

Fig. 4 is a front view of a hard-wood ring which serves to hold the rear electrode and carbon granules; Fig. 5 is a cross-section of this ring. The hole, *g*, in the center of the ring, forms the chamber to hold carbon granules, and is 1¼ ins. in diameter. The circular recess, *h*, on the rear side of the disc, forms a pocket for the back electrode, C, which is a carbon disc 1½ ins. in diameter and ⅛ in. thick. The recess, *h*, should be just a shade less than one-eighth of an inch in

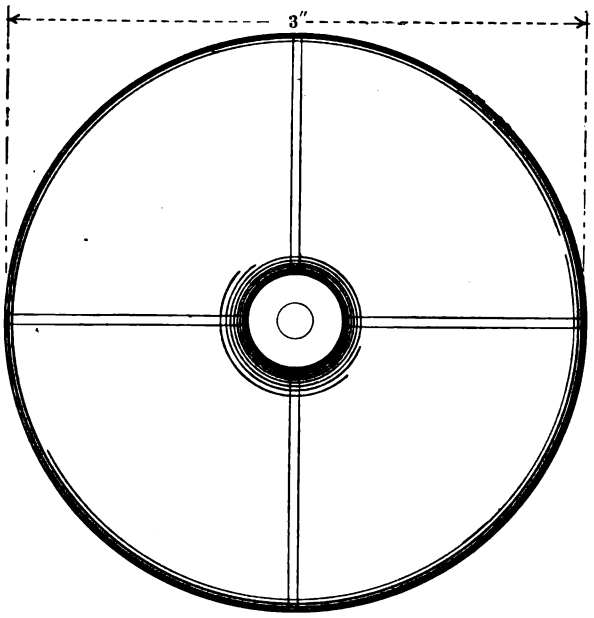


FIG. 7.—VIEW OF REAR CAP.

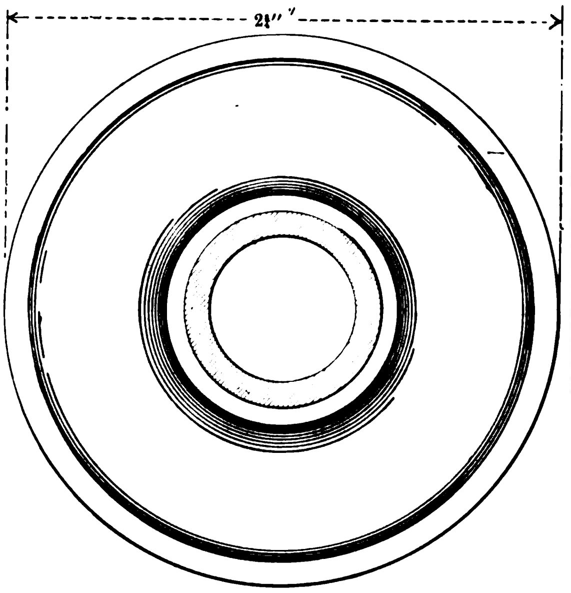


FIG. 8.—VIEW OF FRONT CAP.

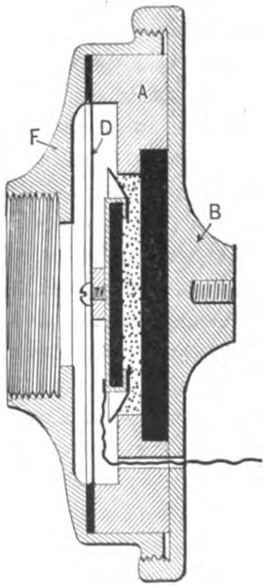


FIG. 9.—SECTION OF COMPLETE TRANSMITTER.

depth, so that the exposed surface of the carbon disc will not be exactly flush with the rear surface of the insulating ring, A. Reference to Fig. 9 will show the object of this arrangement.

When the rear cap, B, a semi-sectional view of which is shown by Fig. 6, is screwed upon the shell, F, of the transmitter, it should come into intimate contact with the back face of the carbon disc, C, so that one terminal of the transmitter can be led from the rear cap. (See Fig. 9.) Fig. 7 is a face view of this cap, from which it will be seen that there are four stiffening ribs extending from the central boss out to the rim. These ribs are 1/16 in. thick, and are provided in order to make the cap rigid and prevent its buckling away from the back electrode. Fig. 8 is a face view of the case or front cap of the transmitter.

The cross-sectional view of the complete transmitter, Fig. 9, shows the carbon chamber nearly filled with granules, and also indicates how the felt ring, *f*, Figs. 2 and 3, serves to keep these granules in the chamber. This ring also acts as a damper to the motion of the diaphragm, D. Connection is made to the front electrode by means of an insulated wire led into the transmitter from the rear through a hole in the cap, B, and the insulating ring, A. This wire is soldered to the thin brass plate on which the front electrode is mounted. In assembling the transmitter a rubber ring should be set in front of the diaphragm so as to be clamped between the diaphragm and the front cap, F. This rubber ring serves to prevent the entrance of moisture to the carbon chamber through the mouth piece.

The receiver is of the Ader bipolar type. A cross-sectional view is given by Fig. 10, and Fig. 11 is a plan view of the receiver case and magnet with the rubber ear-piece removed. Referring to Fig. 10, M is a permanent magnet made of tool steel 3/16 in. thick and ½ in. wide, bent to a circle of 2 ins. inner diameter. The tips of the magnet are shaped as shown by the detail sketch in the center of the ring, and to these are bolted soft-iron pole-pieces, P, P. The screws which hold the pole-pieces to the magnet poles also hold the receiver cup, K, in position. This cup is made of brass or any other non-magnetic material, and is circular, as shown by Fig. 11. The pole-pieces, P, P, are merely right-angle pieces of soft iron, preferably wrought iron, of the dimensions and shape shown by Fig. 12. It will be noticed that the upper ends of the pole-pieces are rounded off instead of being perfectly square. The cup, K, is 15/32 in. deep over all, and its wall is 1/16 in. thick.

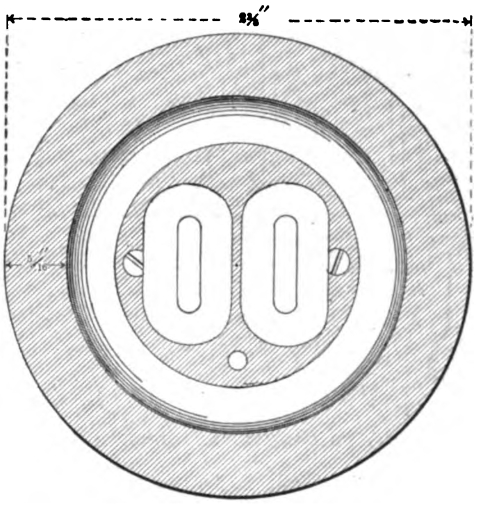


FIG. 11.—PLAN VIEW OF RECEIVER CASE.

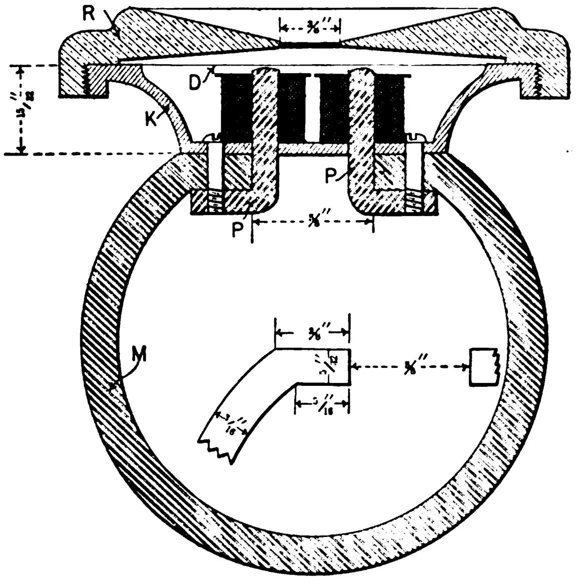


FIG. 10.—SECTION OF BIPOLAR RECEIVER.

The diaphragm, D, is a tin disc 2¼ ins. in diameter and 0.01 in. thick. It is held on the rim of the cup by the rubber ear-piece, R, which is screwed to the outer edge of the rim in the usual manner. Should the reader make the wall of the receiver cup of any other thickness than 1/16 in., care must be observed to have the bottom of the cup exactly accurate, as any variation will effect the dimensions of the magnet coils and, consequently, the working of the receiver.

The receiver coils consist of No. 36 silk-covered wire, each coil containing exactly 125 ft. of wire. The coils should be wound on bobbins made of thin vulcanized fiber, and the terminals may be soldered to the ends of a length of silk-covered lamp cord, say, No. 22. Before making this connection a knot should be tied near the end of the lamp cord, and when the magnets and coils are assembled the free portion of the cord should be threaded through a hole in the bottom of the receiver cup, located as shown in Fig. 11. Part of the heads of the screws which hold the structure together will have to be cut away after the magnet and cup are bolted together in order to allow the magnet coils to go down flat on bottom of the cup. The coils may be held in place by using shellac varnish applied to the bottom of the cup and to the heads of the coils next to it.

A sectional view of the induction coil is given by Fig. 13. The primary coil consists of two layers of No. 20 silk-covered wire wound on a bobbin measuring 2½ ins. between heads and having a ⅜-in. hole through its center. The bobbin tube may be made of thin fiber and the heads of hard wood. The secondary coil consists of 2000 ft. of No. 33 silk-covered wire wound over the top of the primary coil after wrapping three or four layers of oiled paper over the primary. Both terminals of the primary coil should be led out at one head and those of the secondary coil out through the opposite head. The core of the induction coil consists of fine soft-iron wires, about No. 24 gauge; as many of these should be used as can be packed into the hole through the center of the bobbin.

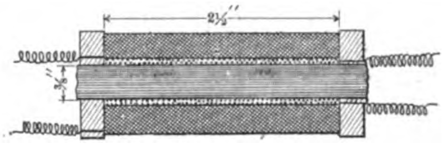


FIG 13.—SECTION OF INDUCTION COIL.

The hook switch is shown by Fig. 14, and consists of a simple strip of metal 6½ ins. long and ⅛ in. thick, having a hook formed at its outer end and being pivoted at its inner end to a brass bracket. The width of the switch at the pivot is ½ in., and this is tapered uniformly to ¼ in. near the hook. The thickness of ⅛ in. is the same throughout its length. The details of the bracket are shown in the upper part of the engraving. The bracket itself is merely a right-angle casting ⅛ in. thick everywhere except at its upper end, where it is 3/16 in. thick in order to give a good hold to the thread of the flat-head screw on which the lever is pivoted. The head of this screw should be of the same

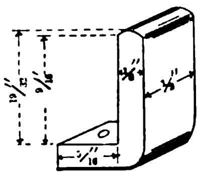


FIG. 12.

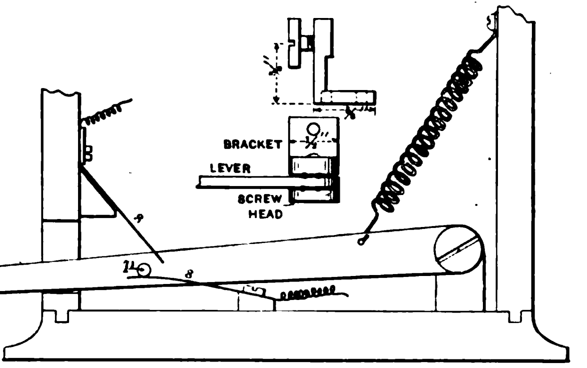


FIG. 14.—DETAILS OF THE HOOK SWITCH.

diameter as the width of the vertical lug of the bracket in order to prevent any tendency on the part of the lever to wabble sidewise. The contact springs, *s*, *s*, may be made of phosphor bronze or thin German silver. A brass pin, *p*, ⅛ in. in diameter and 1 in. long, is mounted in the center of the lever 3¼ ins. from the pivot hole. This pin serves as a contact for the switch springs, *s*, *s*. The lower spring is mounted on a wood block 3/16 in. high at its front edge, ⅛ in. high at the back edge, and ⅝ in. wide between these edges.

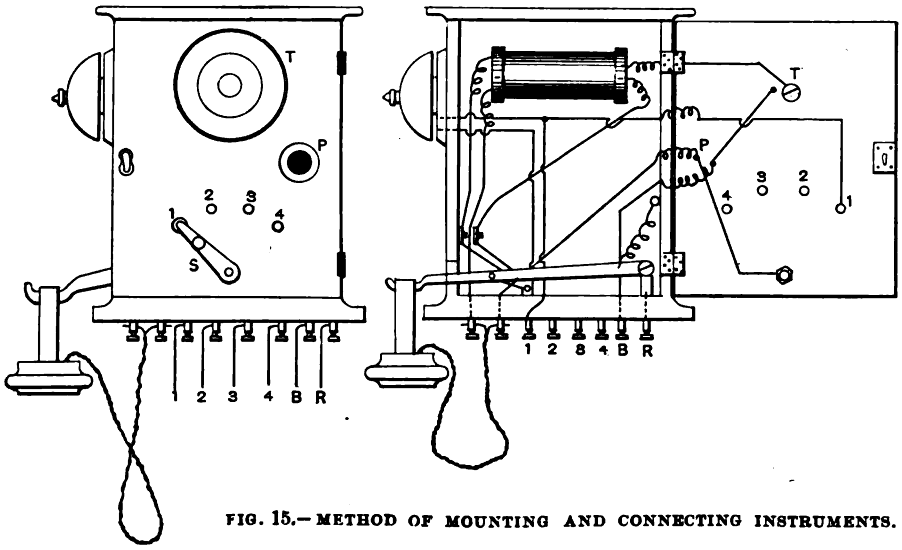


FIG. 15.—METHOD OF MOUNTING AND CONNECTING INSTRUMENTS.

The screw which holds the spring on this block may be an ordinary wood screw sunk into the floor of the box, but it is preferable to have the block either glued to the floor of the box or fastened to it separately, using the screw only to hold the contact spring down. The wire leading to this spring should be soldered to its back end, so that the contact will be permanent regardless of the condition of the screw. There are two of the upper springs, but as they are in line with each other only one shows in the drawing. These are held to the side of the box by means of thin brass plates screwed down with ordinary wood screws. A triangular block of wood should be provided immediately beneath the springs in order to prevent them from following the pin, *p*, too far when the hook is pulled downward. This sketch is exactly one-half size, so that any dimensions which are not marked may be taken from it by a rule.

Although the reader may mount his apparatus in any way he pleases, it is suggested that it be mounted as shown by Fig. 15, in which, T, is the transmitter bolted to the front of the box; P is an ordinary push-button; and S is the selective switch, consisting of an ordinary strap switch with as many contact buttons as there are stations. The connections within the box are shown in the right-hand part of the engraving. In this sketch one of the two upper springs of the hook switch is shown detached from the side of the box in order to clearly indicate the connection between it and the primary of the inductive coil. The upper hinge of the door is shown as forming the connection between the other end of the inductive coil primary and the transmitter, but the hinge need not necessarily be used. The wire can be carried across from the stationary part of the box to the door by coiling it into a long spiral, as indicated in the other three connections, and tacking it down at each end of the spiral. The connections between binding posts, 2, 3 and 4, and the nuts, 2, 3 and 4, on the inside of the door are not shown.

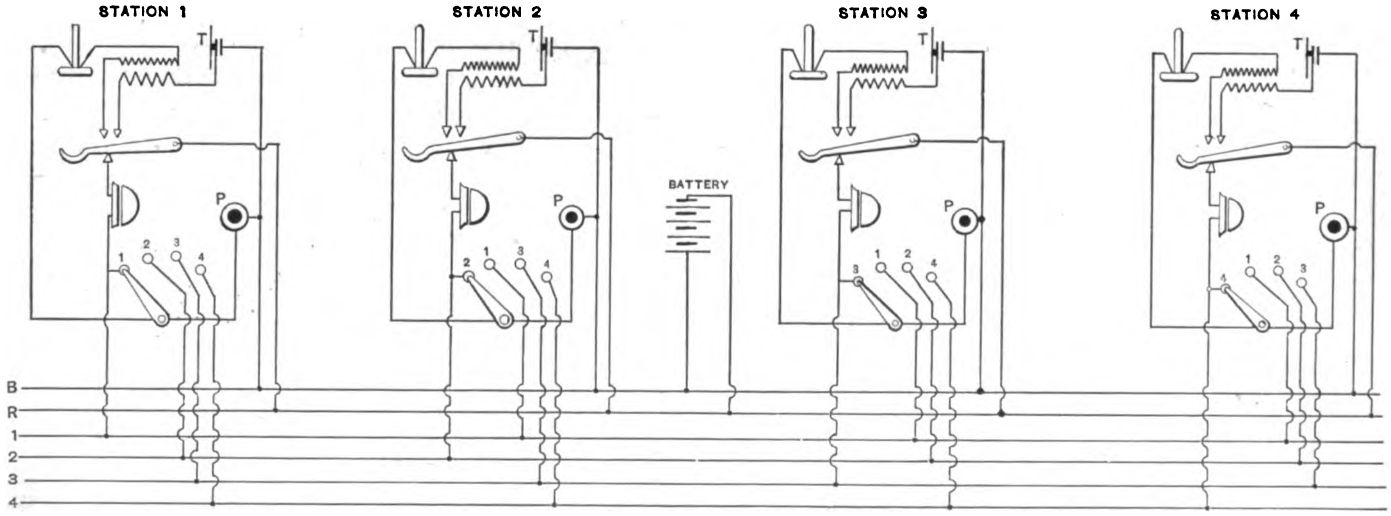


FIG. 16—DIAGRAM OF CONNECTIONS FOR FOUR INTERCOMMUNICATING TELEPHONE STATIONS

As the sketch is a small one and the lines are necessarily very close, it may be advisable to enumerate the connections; these are as follows: From the left-hand receiver post to one end of the induction coil secondary; from the right-hand receiver post to one side of the push-button and also to the lever of the selective switch; from binding post No. 1 to one terminal of the bell and also to button No. 1 of the selective switch; from binding posts Nos. 2, 3 and 4 to buttons Nos. 2, 3 and 4, respectively, of the switch; from binding post, B, to the secondary terminal of the push-button and also to one terminal of the transmitter; from binding post, R, to the lever of the hook switch; from the lower spring of the hook switch to the second terminal of the bell; from one of the upper springs of the hook switch to the unconnected secondary terminal of the induction coil (one terminal having been already connected to the left-hand receiver binding post); from the other upper spring to one primary terminal of the induction coil; and from the other primary terminal to the unconnected terminal of the transmitter (one terminal having been connected to the push-button and binding post, B).

The connections of the system are shown by the diagram, Fig. 16. In this diagram only four stations are indicated, but it will be evident that any desired number may be put in by simply adding one individual line and one selective switch button for each additional station. The arrangement used is a common-battery system, only one battery being required for both signalling and talking. It is recommended that the reader use a bell of what is known as the King type, as indicated in Fig. 15, but, of course, any ordinary vibrating bell will answer. It will be evident from an inspection of the diagram, Fig. 16, that no magnetos are necessary. It should be noted that the left-hand button of the selective switch at every station is connected to one terminal of the bell and to the individual wire the number of which corresponds with the number of that station. The battery is shown located midway between the extreme ends of the main circuits, and this should be the practice if possible.

In operation the procedure is to move the switch, S, to the button corresponding to the station desired and press the push button, P. This rings the bell at the desired station and conversation may be carried on by removing the receiver from the hook switch, allowing the latter to be drawn up in the usual manner. After the conversation is finished the selective switch, S, should always be returned to the home button. Should this be neglected conversation cannot be carried on with the station at which the switch has not been returned.

REPAIR SHOP NOTES.

BY ARTHUR B. WEEKS.

When removing an armature for truing up the commutator, the nuts at the end of the commutator should always be tightened, as they are frequently the cause of the truing being required.

Current should never be turned on an armature until it has been thoroughly dried. Should a set of car heaters be available, and no oven, a temporary one can be rigged up in a few minutes by placing the armature in a convenient spot with the heaters around it, and having boxes so arranged that a canvas thrown over them will cover the whole. The best place for an electric oven is below the shop floor, covered by a hinged lid; in this way no valuable floor space is used. Line the box with sheet iron, and have it only large enough to accommodate the largest apparatus that may be put into it. Arrange some sort of hoist above it, if it be only a span wire thrown over a beam and let down the proper distance, with a loop in the lower end for a chain-block. Fig. 1 shows a simple and useful type of crane for such a purpose or for general use.

In tearing a commutator apart to repair it, if carefully dismantled, it may not be necessary to true the commutator afterward. If the mica rings have been disturbed, replace them as you found them, or a truing cut will be required. A highly discolored bar, due to excessive current and usually occurring when the armature becomes grounded, should be replaced when other repairs are being made; otherwise, a flat place will appear after truing and continue to cause sparking and fusing until the commutator is worn out, which will not be long.

It is always a good plan to mark with a prick-punch the end of a flat or burnt spot that requires truing, so that it may be known if the trouble reappears in the same place, as is often the case. A record should also be made in a book kept for that purpose. Such a record will be found a great help in following up the work.

If your armature shafts are not numbered, stencil them at your earliest opportunity.

The question has been asked often, how thin can a commutator become before replacing it? That will depend to a great extent upon the make of motor. If the commutator is straight across its face, for motors rated at 25 horse-power or under, 3/16 inch is a safe limit. Then again the brush-holders may limit such thicknesses, for it may not be possible to adjust them to get this amount of wear; however, the commutator should be removed before there is any danger of its wearing through.

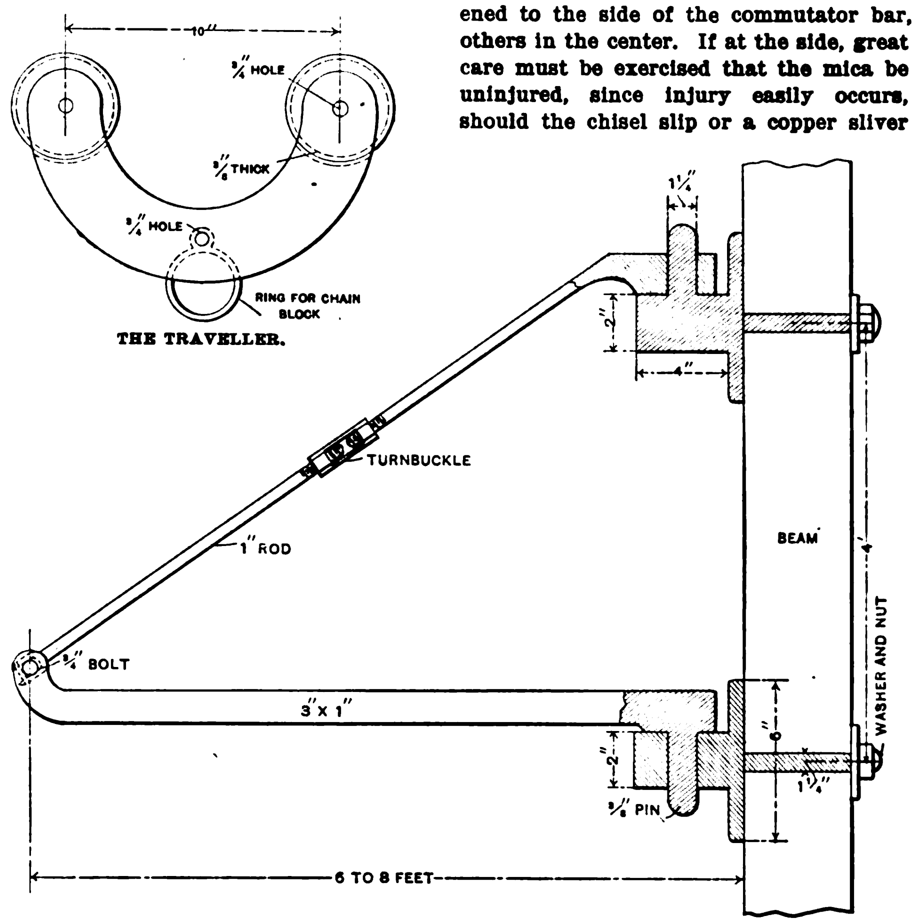
Whenever you have an armature out to be repaired, and there are one or more dark bars on the commutator, re-solder the leads to such bars, for frequently the cause is a poor contact which has made the machine spark more or less. The writer has seen connections in such condition that a little pressure would push the wires out of the slot.

The commutator connections on a generator armature sometimes break off, especially if such connectors are thin, flat copper strips and extend straight up radially to meet the armature conductors. They break off close to the commutator, and if a steady white spark is noticed all along the row of brushes, when just before there was practically no spark, it is pretty certain to be caused by a loose or broken connection. The longer it runs in this condition the worse it becomes, and the greater the amount that will be required to be taken off the commutator to true it.

Some plants shut down machines only on certain days for cleaning, so one must be able to detect such trouble immediately and have the dynamo shut down as soon as possible, to save time and expense in turning. Do not try to make yourself believe it is due only to a poor brush, or that it will soon stop, for it will not. Only by the study of the different kinds of sparks can you tell their meaning, and it is a study well worth one's while.

It is often impossible to detect a broken bar connection with the eye, but a pine stick pried gently between connections will locate it. To repair it requires considerable skill and sound judgment. First, disconnect the broken connector from the armature conductor. In some cases they are fastened with stove bolts and are also soldered.

Before using a blow-lamp protect the adjacent bars with sheet asbestos pushed between bars. When the broken connector is disconnected, cut a slot in the commutator bar with a cape chisel a little narrower than the connector which is to be fitted into it. Some connectors are fastened to the side of the commutator bar, others in the center. If at the side, great care must be exercised that the mica be uninjured, since injury easily occurs, should the chisel slip or a copper sliver pierce it. Next fit the new connector into its place and pack asbestos back of the connection to prevent short circuit from the solder. Have at least two blow-lamps in case one gives out, lest the joint get cold and cause a delay. Use solder and acid cautiously. Being satisfied that the joint is all right, remove all loose solder and asbestos. Turn the armature over by hand and blow it out, as pieces of metal are apt to drop in between the connectors and wedge themselves there. If the instruments are available (as they should always be) test the commutator for short circuits. Then, being satisfied that everything is all right, paint the new connection and others near it with an insulating paint.



THE TRAVELLER.

FIG. 1.—CRANE FOR REPAIR SHOP USE.

INTERIOR WIRING.

BY CHARLES E. KNOX.

THE LIGHTING OF A DEPARTMENT STORE.

Although the lighting of a store building is apparently quite simple, there are several points in connection therewith which require considerable thought and attention in order to obtain the best results. It will be the object of this article to discuss these few points. The first problem to be considered is the system of general lighting (that is, arc or incandescent) that is best adapted for the case in hand. It is quite safe to say that in the large majority of cases the arc system is best adapted for the general lighting of a department store. This is true because of a number of reasons, probably the chief of which is that the light from an arc lamp possesses more nearly the characteristic properties of the sunlight than does that from an incandescent light. This feature of the arc light is particularly valuable in a department store, where color values and matching of colors is such an important consideration. The modern arc light also makes a store more attractive and brilliant in appearance than does an incandescent lighting system.

The arc system having been determined upon, the question of the kind of arc lamp to be used is disposed of quite readily; there is little room for doubt that the long-burning constant-potential enclosed-arc lamp is best adapted for indoor purposes. This lamp will burn on an average 125 hours without having to be retrimmed, although the globe must usually be cleaned oftener than the lamp has to be retrimmed. It has also the important advantages (over the series open-arc lamp) of reducing the danger to life and property, and also reducing the risk of fire and consequently the fire insurance premium. The constant-potential arc lamp also admits of being wired on the same circuits as the incandescent lamps, which simplifies and reduces the cost of wiring.

The next point to be determined is the arrangement and location of the arc lamps themselves. This problem is one that admits of unlimited discussion and a number of solutions. It must be solved to suit the particular case and conditions, and no general law will apply to it. As a rule, the lamps are placed (on the ceiling) over the main aisles. The distance between the lamps depends upon circumstances; sometimes the distance between lamps is determined by architectural conditions, such as columns, ceiling panels, etc. The writer has seen arc lamps in a department store as close together as 10 ft. and as far apart as 30 ft. For ordinary cases they should be arranged so that the distance between centers would be somewhat between the figures mentioned above.

The first point to be determined in wiring a constant-potential arc-light system is the number of arc lamps to be wired on each branch circuit. If it be decided to wire but one lamp on a circuit, the wiring is simplicity itself. If more than one lamp be wired on a branch circuit, the grouping of the lamps on the various circuits should be carefully considered. If the potential is from 100 to 115 volts (and for a department store no other need be considered) it is unwise to put more than two arc lamps on a circuit. As a rule, wiring two lamps on a circuit gives good satisfaction and the cost of wiring is quite a little less than when only one lamp is wired on each circuit. The latter method has the advantage of simplifying the control, and of allowing all the fuses to be placed at the distributing centers. When two arc lamps are placed on a circuit the rules of the National Board of Fire Underwriters require that a fuse cut-out be placed at or near each lamp. If one lamp only be connected to a circuit, No. 14 B. & S. wire may be used for the branch circuits; when two lamps are placed on a circuit it is preferable to use No. 12 B. & S. gauge. Under ordinary circumstances the best results are obtained (where two lamps are grouped on a single circuit) by wiring the lamps in alternation. This method is in some cases undesirable, and the question must be decided on the merits of the case. As a rule, it is desirable to provide a switch in the cut-out cabinet to control each branch circuit, though in some cases it is better to control each lamp by the switch located on the lamp itself.

In regard to the feeders for constant-potential arc-lamp systems, it might be well to add that a slightly greater loss may be allowed than for an incandescent lighting system, for the reason that the regulation need not be as close as in the latter system, and also because a portion of this loss may take the place of the resistance forming a part of the lamp itself.

Having considered the question of general lighting, it may be advisable to speak briefly of special lighting. Under this head would come window lighting, show-case lighting, office lighting, etc. Such lighting is of course best obtained by means of incandescent lamps. Remarkably fine results in window lighting are now obtained by placing a row of incandescent lamps in a suitable silvered glass reflector having the proper curvature or angle and arranged along the upper front edge of the window. If the reflector be properly placed and of the proper form the light will be diffused over the entire window without allowing the lamps them-

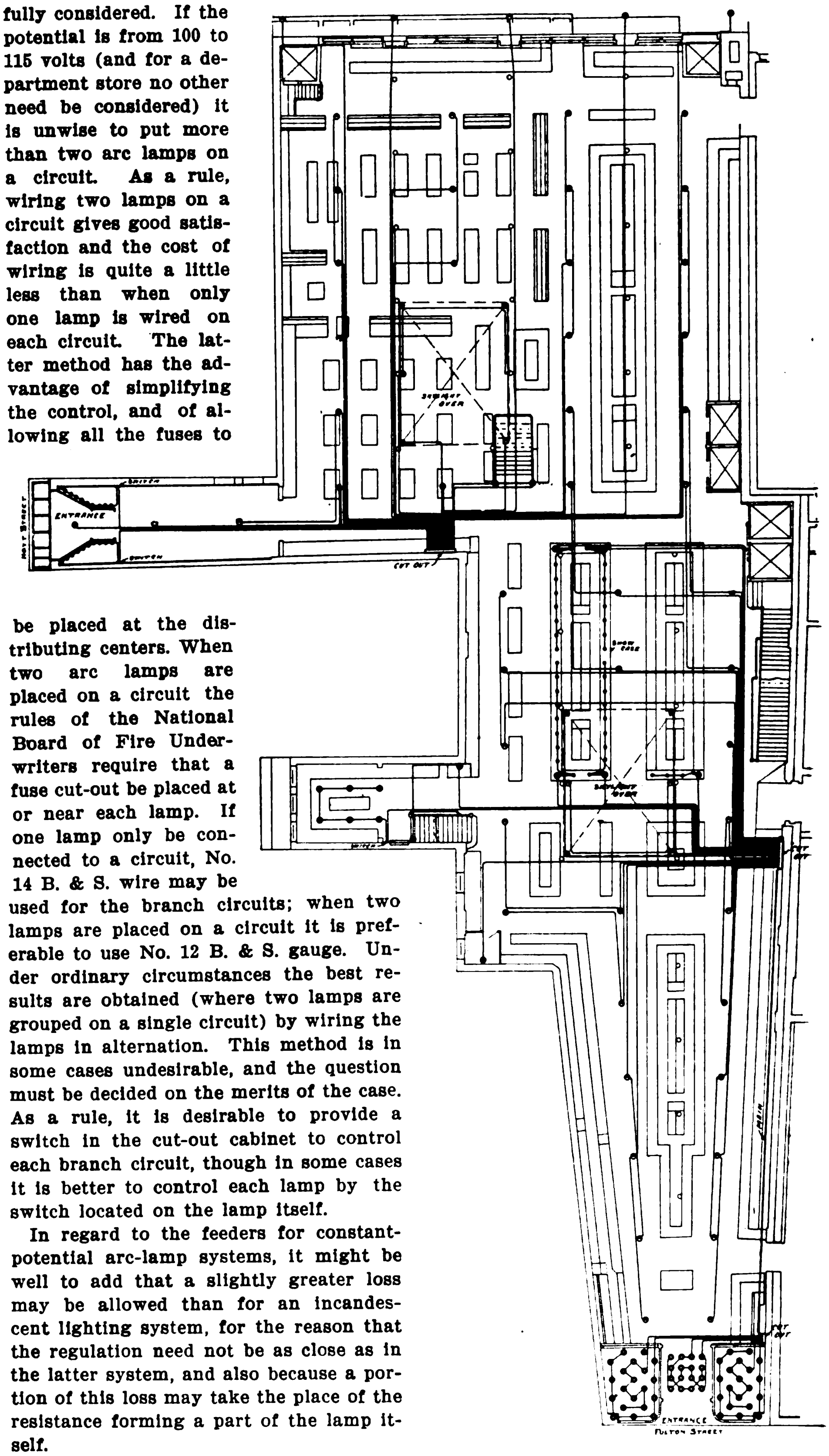


FIG. 1.—WIRING PLAN OF THE FIRST FLOOR.

selves or their direct rays to be visible to the observer from the outside. The same results may be obtained by similar means in certain forms of showcases. In some instances, however, it is better to use individual reflectors for both window and showcase lighting. The lighting of the offices of a department store does not differ materially from ordinary office lighting, and as this has been described in previous articles it need not be dwelt upon here.

As an example of department store lighting, a typical case has been selected and a floor plan showing the number, arrangement and wiring of the lamps is shown in Fig. 1. This diagram shows the first floor plan of one of a group of buildings which form the principal department store in Brooklyn, N. Y. The building is irregular in shape, faces Fulton street and has entrances on two other streets. It consists of a basement and four stories. As the general lighting of all the stores is more or less similar it has been deemed sufficient to show but one floor, as this floor will show the peculiar features of all the others. It will be seen from the plan that arc lamps have been used entirely for general lighting, except at the Fulton street entrance, and in the small extension near the Hoyt street entrance. In the former case incandescent lamps were used because the ceiling was divided in small squares or panels and was therefore well adapted for such lamps, and also because they would interfere less with the lighting of the windows, where incandescent lamps were used. In the case of the short extension, the head room did not admit of the use of arc lamps.

It will be noticed from the plan that the arc lamps are, as a rule, located over the main aisles, except the 12 lights located around the two skylights, where for obvious reasons it was impossible to follow this rule. The distance between the centers of the lamps (in the other direction) varies from 16 to 20 ft. This distance is governed by the columns, the lamps being placed midway between the columns in all cases, with the exception noted above. The six lamps around each skylight are placed at the four corners, with two midway between the corners on the longer sides. These lamps were suspended beneath the skylight by means of long iron brackets. In all other cases the lamps were suspended from screw hooks. Owing to the great height of the first story it was necessary to use extension tubes for supporting the lamps. In this case the screw hooks were screwed into hollow extension tubes, which were fastened to the ceiling, the hook being screwed to the lower end of the tube. At the other floors (the height of stories being less) the hooks were fastened directly to the ceiling. The lamps used were constant-potential enclosed-arc 150-hour lamps. Their resistances were adjusted for, and the lamps are used on circuits having a potential from 95 to 100 volts. Opal inside and outside globes are used. Each lamp is equipped with a switch located at the top of the lamp.

The lamps are mostly wired two on a circuit, and in alternation. The circuits are supplied from two distributing centers, located at the points shown on the plan. Each branch circuit is controlled by a push-button switch located at the cut-out cabinet. Each distributing center is also provided with a knife switch to control the entire group of circuits supplied from that distributing center. No. 12 B. & S. wire is used for the branch circuits. A double-pole fuse cut-out is placed near and connected in circuit with each lamp.

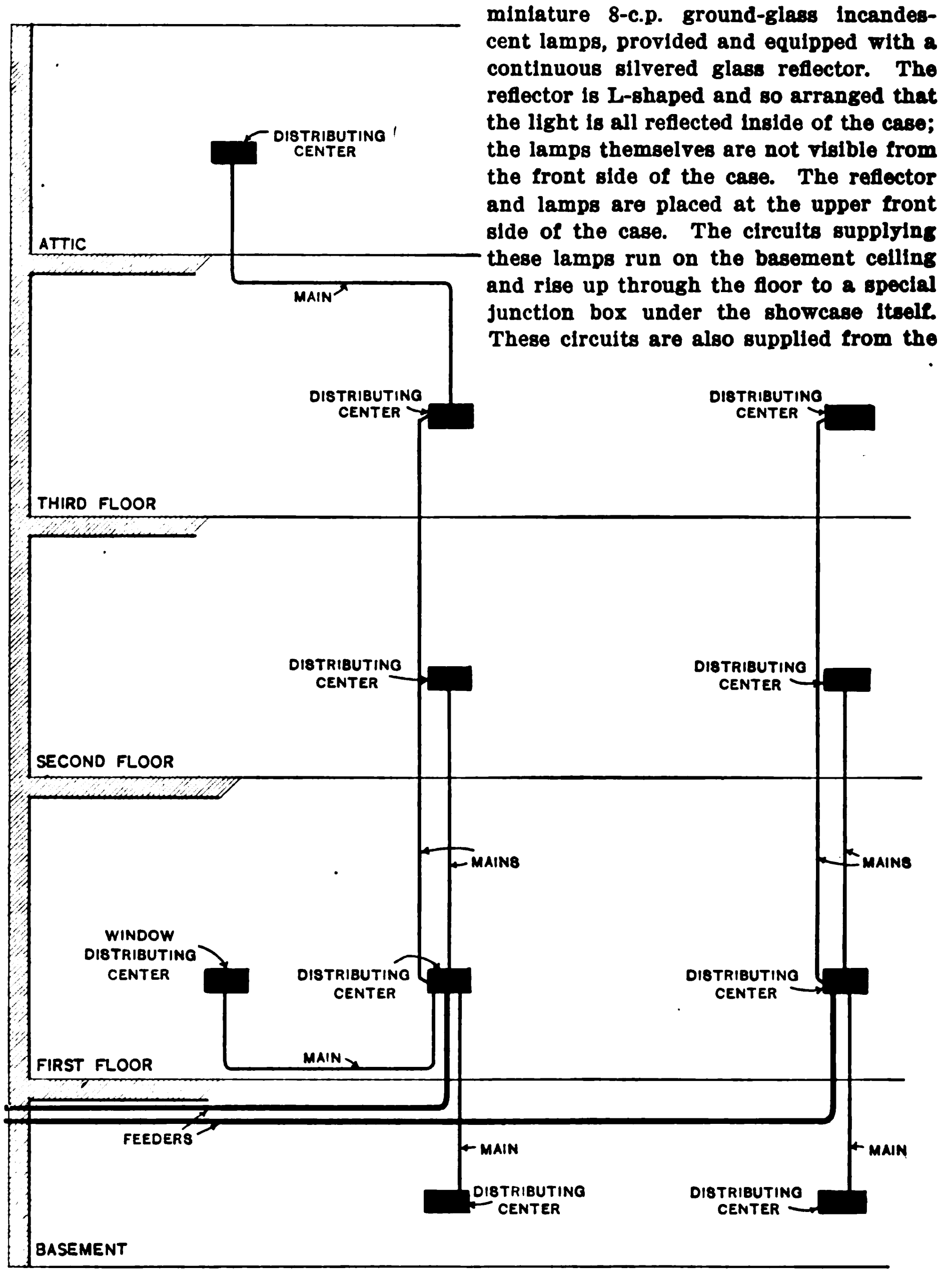


FIG. 2.—LAYOUT OF THE FEEDERS AND MAINS.

The arrangement of feeders and mains is shown in Fig. 2. For the purposes of current supply the building may be considered to be divided into two symmetrical vertical sections, each section being supplied by a separate feeder from an electric plant located in an adjoining building. Each feeder terminates at the first floor; the distributing centers at the basement and upper floors being supplied by mains extending from the first floor. Each feeder is two-wire and of 1,500,000 circular mils sectional area.

The special lighting in the windows is effected by means of incandescent lamps arranged as shown on the plans. Each lamp is set in a ceiling receptacle secured to the ceiling and equipped with a silvered glass reflector. The group of lamps in each window is wired on two special branch circuits originating at a special (window) distributing center, as shown in Fig. 1. This center also supplies the lights at the Fulton street entrance. It is supplied from the same system of feeders and mains that supplies the arc lamps.

The lighting of the showcase near the center of the store is effected by means of miniature 8-c.p. ground-glass incandescent lamps, provided and equipped with a continuous silvered glass reflector. The reflector is L-shaped and so arranged that the light is all reflected inside of the case; the lamps themselves are not visible from the front side of the case. The reflector and lamps are placed at the upper front side of the case. The circuits supplying these lamps run on the basement ceiling and rise up through the floor to a special junction box under the showcase itself. These circuits are also supplied from the arc-light system of feeders and mains. The arrangement of lights in the two showcases at the Hoyt street entrance is the same as in the showcase in the middle of the store. Two special circuits supply two outlets in the newel posts at the head of the basement stairs.

◆

Wireless Telegraphy for French Warships.—A cable dispatch states that the French Government has decided to provide its entire Mediterranean squadron with wireless telegraph apparatus.

COMMON BATTERY TELEPHONE SWITCHBOARD SYSTEMS.

BY W. S. HENRY.

In many switchboards with combination listening and ringing keys arranged to normally ring only through the calling plug, there is an extra push-button by means of which the generator may be connected to the answering plug. This avoids the necessity of interchanging the plugs in case it is necessary to ring up the original calling subscriber, and gives what is sometimes called the ring back. This remark applies to the type of switchboard described in the last article.

A common battery or central-energy system is generally understood to mean one in which all batteries and generators, not only those for ringing up a subscriber, but also those for calling up the switchboard operator, and for supplying current to the subscribers' transmitters, are located at or near the switchboard. Moreover, it is desirable to make one battery supply current for all the subscribers' telephones. Even if located at one central point, a separate battery for each two subscribers that were talking together through the switchboard would be very inconvenient and troublesome, to say nothing of the cost of so many cells.

Before describing a common-battery switchboard system it will be well to consider the principle of some methods that may be employed. In any case it is necessary that the variable resistance of the microphone shall be relatively large in order to alter by an appreciable amount the total resistance of the circuit in which it is connected. The larger the constant resistance in the microphone circuit the less will a given change in the microphone resistance vary the current. By using a transmitter in a local circuit with the primary of an induction coil a current varying between wide limits can easily be obtained in the local circuit, because then the variable resistance of the microphone is an appreciable part of the total resistance of the local circuit. This current causes an alternating electromotive force to be induced in the secondary coil of such a high value that sufficient current is sent through the relatively high resistance secondary circuit to operate the receivers satisfactorily. In the simplest common-battery system where the receivers, transmitters and battery are in series in the same circuit, it is not so easy to make the microphone vary the total resistance of the circuit enough to give satisfactory results. Consequently this simple method is seldom used.

Improvements in the construction of microphone transmitters have, however, helped to make common-battery systems successful. Microphones as now made for common-battery systems have resistances anywhere from 30 to 90 ohms; formerly the resistance of a good microphone only amounted to a few ohms. Of course merely a high resistance in the microphone is not desirable, but if two microphones vary in resistance by the same per cent then the high-resistance one is the more desirable, because it produces the greatest percentage change in the total resistance of the circuit. A good microphone should also be able to carry the necessary current without excessive heating. Microphones for common-battery systems require from .15 to .17 ampere.

There is a considerable number of common-battery systems that differ in principle as well as in details of construction. The Bell companies' systems depend upon a plan devised by H. V. Hayes and represented diagrammatically by Fig. 1. In this diagram two subscribers' stations, S and N, are shown connected together through the apparatus at the central exchange, D, where the common battery, B, and two repeating coils, *o*, *o'*, and *c*, *c'*, are located. These repeating coils are merely induction coils having two coils of equal resistance and the same number of turns. They are wound upon a soft-iron wire core, so constructed that it forms a closed magnetic circuit, and in practice the four coils, *o*, *o'*, *c*, and *c'*, are wound upon the same iron core. The repeating coil used by the Bell Telephone Company is made about as follows: The iron core is ½ in. in diameter by 6 ins. long. The two ends are ¼ in. thick and the center division ⅛ in. thick. The two winding spaces are about 2 11/16 ins. long, each space containing room for two windings. Each winding has 16 layers of No. 26 single silk-covered wire. The two inner windings have a resistance of about 20 ohms each, and the outer windings about 34 ohms each. One inner and the opposite outer winding having a resistance of about 54 ohms, form one-half of the repeating coil, the remaining two windings form the other half.

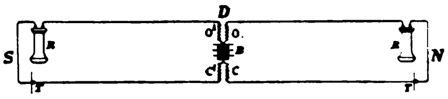


FIG. 1.—THE HAYES SYSTEM.

At the subscribers' stations the transmitters and receivers are shown connected simply in series for the sake of simplicity, but, as a matter of fact, the arrangement is usually quite different, as will be shown later. When the two subscribers' stations are joined together through the switchboard connections, the current from the positive pole of the common battery, B, will divide and pass through the separate windings, *o* and *o'*, of the repeating coil to the live wires leading to subscribers' stations, N and S. The two portions of the current will then flow through the apparatus at the subscribers' stations and return to the central office through the windings, *c* and *c'*, to the negative pole of the common battery, B.

The action of one circuit upon another is as follows: The two circuits may be considered as entirely separate, connected inductively only through the windings of the repeating coil. If the transmitter at station N varies its resistance, the current flowing from the battery through that circuit will vary correspondingly. These variations, passing through the windings, *o* and *c*, will induce electromotive forces in the windings, *o'* and *c'*, producing in the circuit through station S fluctuating currents similar to those in the circuit through station N. When station S is transmitting this action will be merely reversed.

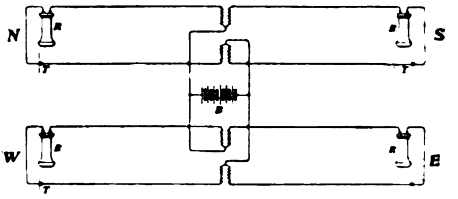


FIG. 2.—ONE BATTERY ARRANGEMENT ON TWO CIRCUITS.

A separate repeating coil must be used at the switchboard in each pair of cord circuits, but the same battery may be employed to serve all the subscribers. Such an arrangement for supplying current from one battery through two separate repeating coils to two separate pairs of subscribers' telephone circuits is shown in Fig. 2. The battery, B, should have a low internal resistance in order to avoid danger of cross talk. Where storage batteries are used there is not the least bit of trouble from cross talk. Low internal resistance primary cells may also be used.

The principle of the system devised by J. S. Stone, also of the Bell Telephone Company, is shown in Fig. 3, where I and I' are two impedance or choke coils that consist of a large number of turns of insulated copper wire wound on a soft-iron wire core; the core being so constructed as to form a complete iron circuit for the magnetic lines of force. The actual shape of the coils is not shown in the figure. The impedance coils are wound with rather large copper wire so that their ohmic resistance may be small and their impedance very large. Hence they will allow steady currents to flow through them quite readily, but will form a practical barrier to rapidly-fluctuating currents such as are produced when telephoning.

The current from the positive pole of the battery, B, will flow through the impedance coil, I', to a point, *b*, where it will divide and pass through each subscriber's station and back to the point, *a*. At this point the two currents will reunite and pass through the impedance coil, I, to the negative pole of the battery. If the two circuits have the same resistance the total current from the battery will divide equally between the two stations. Suppose the resistance of the microphone at E increases, then the resistance of the two circuits will no longer have the same

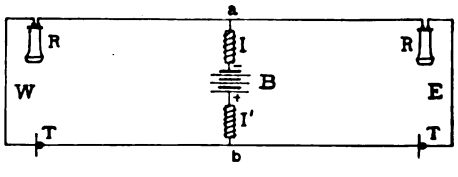


FIG. 3—THE STONE SYSTEM.

relation to each other as before. Moreover, the impedance coils in the bridged circuit with the batteries prevent any appreciable fluctuation in the total current from the battery, and hence it is evident that there will be quite an appreciable decrease in the current through W and a corresponding increase in the current through E. If the resistance of the transmitter at W decreases there will be an increase in the current through W and a corresponding decrease in the current through E. Consequently a rapidly-fluctuating current will flow through E when one speaks into the transmitter at W. In a similar manner the receiver at W will respond when one speaks into the transmitter at E.

By arranging the circuits as shown in Fig. 4 a single battery may serve for a large number of cord circuits. Each cord circuit must be connected through a separate pair of impedance coils with the common battery. Fluctuating currents produced by the operation of the transmitter at E will be confined to the line circuit containing E and W because the impedance coils, I and I', form, as already stated, a practical barrier against the passage of such currents. Even if a small portion of the fluctuations did pass through the coils, I and I', and produce fluctuations in the current through the battery, B, no cross talk would be produced in the other circuit because the battery, if the proper kind is used, has such a low internal resistance that the fluctuating current through it does not produce a fluctuating electromotive force at the battery terminals. Hence there will be little or no tendency for the circulation of a fluctuating current through the impedance coils, J and J', and the subscribers' stations, S and N. Moreover, if there was set up a fluctuating electromotive force at the terminals of the battery, the impedance coils, J and J', would offer such a high impedance that very little or no fluctuating current could get through them. Hence, for the two reasons stated there would be very little or no cross talk produced.

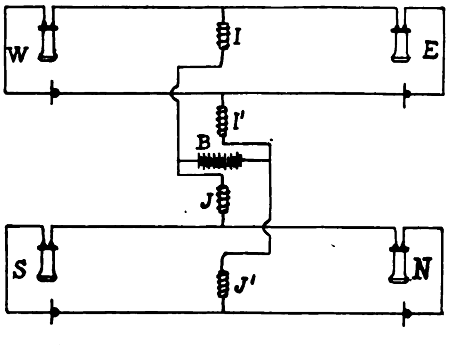


FIG. 4.—COMMON-BATTERY ARRANGEMENT FOR A NUMBER OF CIRCUITS.

The Dean system, shown in Fig. 5, employs an induction coil at the subscribers' station, thereby retaining the advantage due to the use of induction coils. The two subscribers' telephones, N and S, are connected with the central station, D, by means of two line wires and the ground. There are similar impedance coils, I, I' and J, at each station and at the central office. A battery, B, is connected between the ground and the center of the central impedance coil, J. The center, 3, of the subscriber's impedance coil is connected through the primary, p, of the induction coil and the transmitter, T, in parallel, and to the ground, G. The secondary coil, s, and the receiver, R, are joined in series across the terminals, 1 and 2, of the impedance coil.

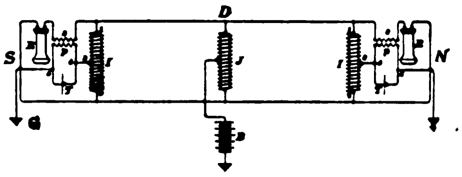


FIG. 5.—THE DEAN SYSTEM.

The current from the positive pole of the battery, B, divides at the center of the impedance coil, J, flowing toward both line wires. Hence this current will not even magnetize the iron core of the impedance coil, J, since it flows around it in opposite directions in the two halves. Hence the iron is in a neutral state, which is its most sensitive condition to repel the passage through the coils of a fluctuating current.

The current flows over the two line wires and the two halves of the impedance coil, I', in multiple to the center point, 3, where the two portions unite and pass to the point, 4. As in the case of the impedance coil J, the current from the battery through the two halves of the impedance coil I' will not even magnetize the iron core, since these currents flow around the core in opposite directions. Hence the iron core remains neutral, and ready to repel the passage through it of rapidly fluctuating currents through the two halves in series. At the point 4 the current again divides, one part passing through the primary coil, p, and the other through the transmitter, T, finally reuniting again at 5 and passing to the ground, G, and back to the battery, B. In an exactly similar manner current from the same battery, B, flows through the lines to station N, and returns by the ground to the battery, B.

Suppose that subscriber, N, is talking. Whenever the resistance of the transmitter at N decreases, a larger portion of the current will pass through the transmitter and a smaller portion through the primary, p, of the induction coil. When the resistance of the transmitter increases a smaller portion of the current will flow through the transmitter and a larger portion through the primary, p. The fluctuating current thus produced in the primary coil, p, will induce an alternating-electromotive force in the secondary coil, s, which will cause the current to flow over the line wires and through station S, operating the receiver there in the usual manner. These fluctuating currents will not pass through any of the coils, I, I' or J', on account of their high impedance to such rapidly varying currents. The voice currents would have to pass through the two halves of the coils in series, and hence, in this case, the two halves would not tend to neutralize one another, but both would tend to magnetize the iron in the same direction. Consequently they offer a very high impedance to the voice currents, but only half the resistance of one coil and line to the current for the transmitter circuit.

AN UNUSUAL CONDITION.

BY E. C. PARHAM.

On a trolley line there is a chance for the line loss or the "drop" to become very great, not only on account of the trolley wire being too small and inadequately supplied with feeders; but on account of the disarrangement, breakage or theft of some of the 350 bond wires to be found in each mile of single track. Each bond wire has two contacts, making 700 joints to the mile, and an imperfection in either contact impairs the usefulness of the bond. The bonds may, to the eye, be in good shape, but each one does not need to have very much of a fault in its contacts in order for the total effect to cause a line loss of 50 or 100 volts. There are many roads where the line loss at a far end of the line amounts to 250 volts. There are other roads on which the loss in places exceeds this, all on account of poor ground returns. In many cases, enough copper could be profitably taken away from the overhead work to properly bond the rails. It is of no use to add more feed wires when the ground return is poor; one might as well poke one part of a water pipe full of sponges and then sand paper and oil the part next to it to make the water flow more freely.

The "unusual condition" forming the particular subject of this article occurred on a 6-mile road where the voltage at the end of the line was so low that a motor car would run up a 5 per cent grade faster with the motors in series than with the controller thrown around to the multiple position. In order to understand the situation, note the following points: In Fig. 1 the motors are shown diagrammatically connected in series in the upper part and in multiple in the lower part of the sketch. The dotted line, x, x, merely indicates corresponding points in the two diagrams. Now, in order for a motor to have a certain pulling power it must have a certain amount of current go through it at a certain voltage. When the motors are in

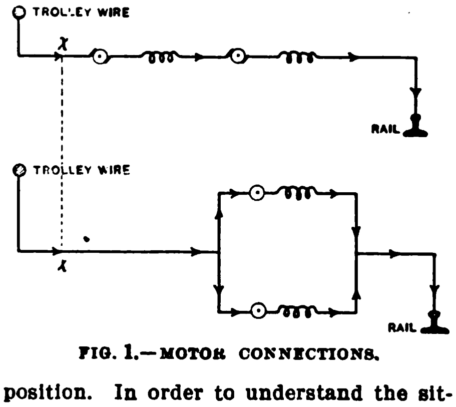


FIG. 1.—MOTOR CONNECTIONS.

series, as shown in the upper sketch, the same current goes through both motors and each one, therefore, gets all of the current that flows in the main line and in any part of the car circuit, as at the point, *x*. But when the motors are in multiple the main line current splits between the two of them, so that in order for each motor to get as much current as it did when they were in series, the main line or total current must be twice as great.

When the motors are in series their counter e.m.fs. are added, of course, and help each other to check the flow of current. As soon as they are thrown into multiple the counter e.m.fs. are no longer added and the ability of the motors to limit the value of the current is much less (practically, about one-half what it was before) so the current taken by the car increases. With the motors in series and the smaller main line current flowing, the line losses amount to a certain value; as soon as the motors are thrown into multiple the main line current increases and the line drop increases at the same rate, because for a given resistance the drop in any line is proportional to the current flowing through it.

Now, the ability of a motor to do work depends upon the amount of power supplied to it, and the amount of work done by a street railway motor is directly proportional to the speed of the car; consequently, if the resistance of the line is so high that the increase of current flowing through the motors when they are connected in multiple pulls down the voltage at their terminals until the current multiplied by the volts is less than the product of amperes and volts when the motors are in series, less power will be delivered to the motors and they will do less work; that is to say, they will not drive the car at as great a speed as before. This was exactly the condition in the case described. With the motors connected in series the number of watts at the motor terminals was greater than when the motors were connected in multiple, on account of the excessive loss; consequently, the speed was higher in series than in multiple.

As intimated in the first part of this article, the greater part of the line loss may be, and usually is, in the ground return through the rails and bonds; consequently, in order to avoid any such contingency as that here described it behooves railway superintendents to make sure that their rail bonds are always in first-class condition.

GLOBE VALVES AND TRAPPED WATER.

BY R. A. DOUGLASS.

There are many little things about a steam plant that for one reason or another do not receive the attention that they deserve. One of these little things, which is really quite essential to the smooth working of a system of piping, is the way in which globe valves ought to set on horizontal pipes. It is just as easy to put them on right as to have them wrong; and yet it is very common to see them put on wrongly. They are shown wrongly, too, in many of the mechanical journals whose editors ought to know better, and even in the trade catalogues that are issued by firms that do know better. These remarks do not relate to the old question of whether the valve ought to shut against the pressure or not, but to the far simpler one of whether the stem of the valve should be upright or horizontal.

A glance at the accompanying engraving will make the point clear. It shows a sectional view of a globe valve that is in position on a line of pipe, with its stem sticking straight upward, instead of off to one side, as it should be. The engraving shows that when a valve is put on in this way, the seat of the valve acts as a sort of dam. Water cannot run through a valve that is set in this position, until it stands as high in the pipe as the edge of the valve seat. When this level has been reached, any further supply of water that may enter the pipe can run over the edge of the valve seat and escape; but the water below the level of that shown in the engraving cannot flow out of its own accord, but must remain in the pipe all the time, unless removed by some cause other than its own natural tendency to run down hill.

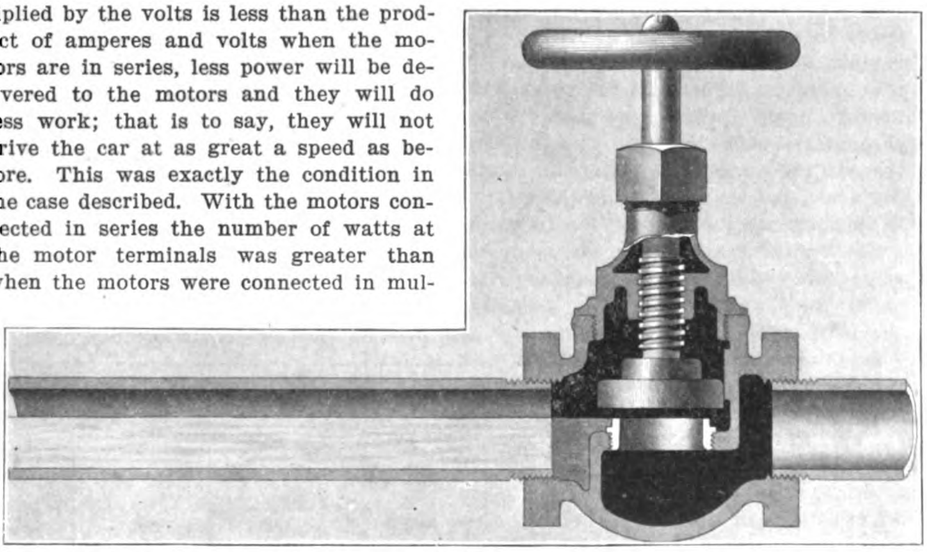


FIG. 1.—SECTION OF GLOBE VALVE SHOWING TRAPPED WATER.

The presence of such trapped water is always objectionable, because under any circumstances it chokes the pipe and lessens its steam-carrying capacity, by diminishing its effective sectional area. This choking effect is hardly worth mentioning, however, in comparison with the trouble that so often follows from turning live steam into a cold pipe half filled with water. Under such conditions, the current of steam causes the water to surge back and forth in the pipe with rapidly increasing violence, until presently the piping begins to "pound" badly, and there is more or less likelihood of a break in the fittings, which may be followed by the most serious consequences if the pipe is carrying steam of high pressure. In heating systems, where the pipes are small and the pressure does not exceed a few pounds to the square inch, there is, of course, no great danger from the water, and yet even in these cases the loud rattling and snapping to which it gives rise are exceedingly annoying. When the pipes are larger, however, and the pressure runs up, perhaps to 75 or 100 lbs., the danger of a rupture becomes correspondingly imminent and grave, and it should be realized and guarded against; for the breaking of a fitting on a large pipe containing steam at a high pressure may do a great deal of damage to property, besides inflicting personal injuries and causing loss of life.

The writer recalls an instance in which an 8-in. globe valve on a high-pressure line of piping burst, apparently on account of the accumulation of trapped water in the pipe; and he was very deeply impressed by this experience with the importance of attending to the drainage of such pipe lines. The valve in question was on a main steam pipe, and every time it was opened the accumulated water in the pipe would be thrown violently about, so that a loud "pounding" was produced, which lasted until the water finally found its way down into the boiler or somewhere else. Things went on in this way until one day the valve gave out. It may be that a crack had been started gradually somewhere by the violent hammering that the casting had received from the water; or it may be simply that the valve was opened quicker than usual on this particular occasion, so that the water-hammer action was unusually severe. At any rate, at the time of the accident steam had hardly been turned into the pipe when a large piece of the valve casing broke away, and a vicious blast of steam blew out into the boiler room, fatally scalding one man and inflicting dangerous and very painful injuries on two others.

Troubles of this kind may be due to incorrect design of a pipe line, for it is by no means uncommon to see a line of pipe put in so that it cannot drain itself under any circumstances, whether the valves are put on correctly or not; but it should be noted that so far as they are attributable to the water-trapping action of a globe valve, they may be entirely avoided by putting the valve in so that its stem lies horizontal. When this is done the valve seat will stand up edgewise (that is, vertically) and cannot act as a dam. The opening in the valve seat is supposed to be equal in diameter to the full diameter of the pipe; hence when the valve seat stands vertically the bottom of the opening in it will be on a level with the bottom of the inside surface of the pipe, so that all the water in the pipe can run through the valve and none of it will be trapped in the manner illustrated in the engraving. As has already been said, it is just as easy to put valves on in this way as to put them on in the wrong way; and, therefore, there is no excuse for making the error under discussion after attention has once been called to it.

FLY WHEEL ACCIDENTS.

BY C. W. OBERT.

There is no part of the steam engine which is more given to accidents than the fly wheel. In spite of careful design, both in the fly wheel and in the engine's governing devices, some component in either is liable at any time to fail and cause a costly, if not fatal, accident. It is a matter of common knowledge that there are many engines that are being run at higher speeds and higher pressures than normal in order to obtain greater power therefrom without the expenditure of an addition to the plant. But this is almost criminal carelessness, as a slight increase of speed in such a case, caused perchance by a slip of the governor belt or the sticking of the governor parts, can set up centrifugal strains in the wheel sufficient to rupture it, and it is certain that many accidents have happened in this way.

The object sought in placing the fly wheel upon an engine's shaft is to "balance up" the unevenness of the engine's working and to tend to keep the shaft revolving at a constant speed regardless of the conditions imposed upon it. When the load on the engine varies suddenly, the fly wheel must either absorb or give out energy, according as the load increases or diminishes, until the governor has had time to regulate the piston effort to the necessary amount. But besides these variations of speed due to outside causes, which it is the function of the governor to check, there are variations from causes within, over which the governor has no control. These internal causes are the varying rate at which the engine does its work, on account of the changes of steam pressure in the cylinder during a stroke and the different leverages that the connecting-rod has on the crank pin in its different positions. As is shown by any indicator card, the greatest steam pressure acting on the piston, does not continue further than from about one-third to one-half stroke in the cylinder of an engine working expansively, after which the piston pressure decreases very rapidly owing to expansion of the steam. And then the connecting-rod does not have nearly as great a leverage to turn the crank when the crank pin is near the dead centers as when it is at the top and bottom quarters.

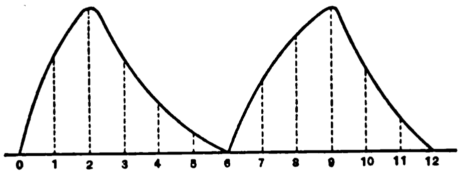


FIG. 2.—DIAGRAM OF CRANK EFFORT.

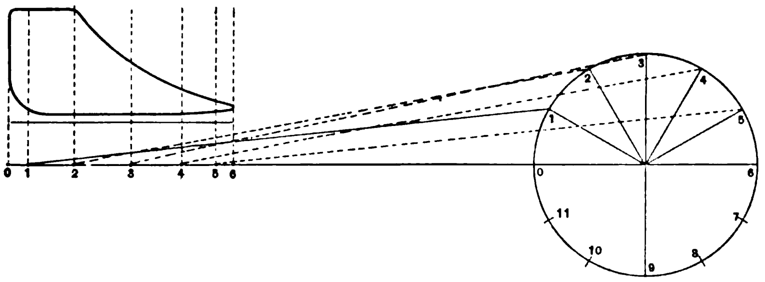


FIG. 1.—METHOD OF FINDING CRANK EFFORT FROM INDICATOR CARD.

As illustrated by Fig. 1, at the beginning of a stroke, just after the crank has passed the inner center, the steam pressure acting on and tending to drive the piston is highest, but the connecting-rod has such a short leverage over the crank that the resulting "crank-effort" is very small. As the crank moves around toward the quarter, the leverage becomes greater and greater, and consequently the crank effort increases until the cut-off takes place. Then the steam begins to expand, causing its pressure on the piston to diminish, and shortly thereafter the crank passes the quarter, and the leverage begins to diminish. The combined result of these variations is that the greatest turning effort delivered to the shaft is exerted at or near the cut-off point of the stroke, while at the other parts of the stroke the turning effort is very small.

The varying value of the turning effort at different positions of the crank pin is shown by the curves in Fig. 2. Now it is the province of the fly wheel to serve as a storage reservoir to receive these extreme turning efforts, and then give them out later in the stroke when the piston is doing less and less work, besides acting as a supply reservoir in general when the load on the engine changes. Therefore, in the design, much care has to be given to properly proportioning the spokes, as well as to the weight of the rim, as the entire effect of the shock of these sudden and repeated changes of effort and load has to be borne by the spokes.

It would seem that a carefully-proportioned wheel should easily withstand the strains due to its intended speed, but there is always the uncertainty of hidden defects in construction over which the designer has no control. If the fly wheel is to be made of cast iron, as most of them are, it is almost impossible to avoid having internal strains come upon it in the cooling after casting, which weakens it. If the spokes are made straight, as is usual, the massive circular rim will, in shrinking, tend to press inwardly upon them, sometimes with almost crushing pressure. Skilled designing and careful handling in the foundry will generally eliminate the evils of unequal shrinkage; nevertheless, if a flaw should exist, it could not be seen, and the fly wheel would operate as a menace to everyone near. Even in the laminated rim and various anti-bursting types of fly wheels there is a possibility of the endangering flaw.

The most common apparent cause of fly-wheel accidents is the slipping of the governor belt or some disarrangement of the governor's mechanism. The cause of the bursting of a fly-wheel in Peoria, Ill., was said to have been the slipping of the governor belt. The fragments of the wheel in this accident destroyed three dynamos and did considerable damage to the structure of the building, crushing massive floor beams, while portions went through the roof and landed a block away.

In the case of the bursting of a 20-ft. fly-wheel in a large steel works it was claimed that one of the governor balls became detached, allowing the engine to race. Although this wheel is said to have been especially well designed and carefully constructed, it flew into fragments, tearing out the entire end of its building and roof.

Sometimes, on the other hand, the engineer becomes confused from excitement and does not choose the wisest course. At the Hoboken electric light station an engineer became "rattled" during the replacing of some burnt-out fuses, and attempted to slow down the engine by raising the governor balls. But he moved the governor mechanism in the wrong direction, as a result of which the engine raced until the fly-wheel burst, tearing out the walls and roof of the station. The unfortunate engineer paid with his life the penalty of his confusion.

One of the most remarkable of these accidents took place at Lynn, Mass., during a slight fire in the wire tower. A general short-circuiting was claimed to have taken place at which the pulleys on the jack shaft crushed, allowing the engine to run away. It was presumed that a flying fragment from a jack pulley deranged the governor mechanism, although the true cause of the engine's running away remains shrouded in mystery. The fragments of the fly-wheel cut a swath through both sides and the roof of the building, one large piece being carried fully 150 ft. and wrecking the corner of a neighboring house.

One of the most recent fly-wheel accidents occurred at South Bend, Ind., Jan. 19. The engine was a 300-h.p. slow-speed, of the Corliss type. The fly wheel was 24 feet in diameter, with a 4-ft. face, and was driven at 65 r.p.m. A nut dropped off in the cylinder, which jammed the piston and threw the crank shaft out of its bearings. The engineer heard the noise in the cylinder and just had time to shut off steam from the cylinder when the fly-wheel flew into pieces. Fortunately no one was hurt. The flying fragments tore a large hole through the engine-room roof and wrecked the engine completely.

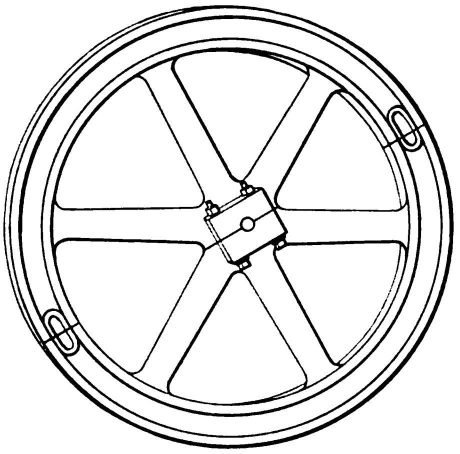


FIG. 3.—LINKED JOINT FLY WHEEL.

A series of experiments has been conducted recently at the Case School of Applied Science, Cleveland, Ohio, to determine the strengths of different kinds of fly-wheels by deliberately running them at sufficiently high speeds to burst them. A great many important points were learned in connection with these tests. It was found, in a comparison of solid and segmental wheels, that none of the segmental wheels were as strong as the solid wheels. These tests revealed the unknown difficulty of properly securing together the two halves of a "split" fly-wheel. Of all the prevailing methods of joining, the linked joints, such as are common in very heavy direct-connected railway generator work, were found to be the best; these proved to be two-thirds as strong as the solid rim which they connected. Joints made in the ordinary manner, with internal flanges bolted together, are probably the worst that could be used for this purpose, as they were found to have only one-fourth the strength of their rim.

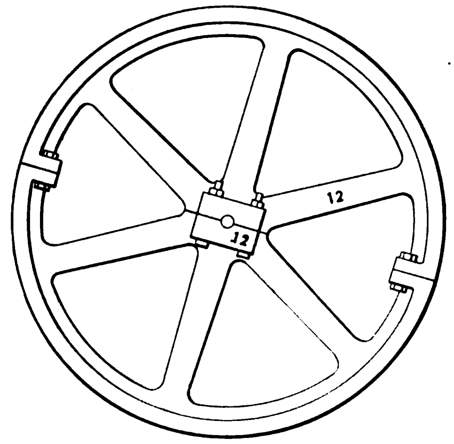


FIG. 4.—INTERNAL FLANGED FLY WHEEL.

It seems rather strange that notwithstanding the availability of several efficient safety stops, fly-wheel accidents due to excessive speed continue to occur right along. There are several devices on the market which are designed to shut off steam from the engine in case its speed should rise beyond a certain predetermined value, wnile others have been attempted which should at least give a signal, electrically or otherwise, in case of such excessive speed. Safety stops of the former types, especially those independent of the governor mechanism, have proven very successful in actual service, and a more general use of them would do much to protect life and property.

If for any reason the use of a safety stop is impractical, some means should certainly be provided for the control of the engine without jeopardizing the safety of the engineer. It should be possible to shut off steam at a moment's warning from a point distant from the engine, or, in the absence of an arrangement of this kind, the throttle valve should be located on the side of the cylinder opposite from the fly-wheel side of the engine instead of on the same side with it, where it is almost always put. This would enable the engineer to handle his throttle without the absolute certainty of being killed in the event of the disintegration of the fly-wheel.

Lessons in Practical Electricity

THE ROTARY MAGNETIC FIELD.

Like the current which produces them, magnetic fluxes due to alternating current have phase relations. If two coils of wire be mounted on a single core and traversed by alternating currents which differ in phase, the magnetic flux produced will be the resultant of the two fluxes which would be produced by the coils separately. Thus, if the currents were equal but differed in phase by a quarter of a cycle (commonly termed 90°), they would be represented by two vectors of equal length, 90° apart, as in Fig. 1. The fluxes produced could be represented by the same vectors, as the magnetic lines rise and fall in the same fashion as the current that produces them; the resultant of the two fluxes, therefore, may be plotted by combining the vectors, as shown in Fig. 2, and explained in the February Lesson.

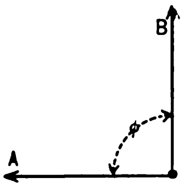


FIG. 1.

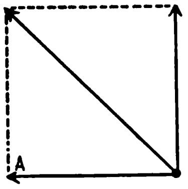


FIG. 2.

Suppose two coils be wound on an armature core as indicated in Fig. 3; the coils being arranged at right angles with each other, the individual fluxes which they produce will also be at right angles with each other, the flux produced by the coil, A, being parallel with the wires of the coil, B, and the flux produced by the winding, B, being parallel with the wires of the coil, A. If the two coils be connected in series, as shown in the diagram, and a current, alternating or otherwise, be passed through them, the two fluxes produced by the coils will combine into a single resultant flux, the direction of which will be midway between the two, as indicated by the dotted lines in the sketch. (For the sake of simplicity the dotted lines are not carried all the way across the core but the lines of force, of course, extend across from side to side.) The strength of this resultant flux is measurable by the parallelogram method, just as the resultant of any other two forces. For example, referring to Figs. 1 and 2 again, if each individual flux has a strength of 100,000 lines then the resultant flux will have a strength of 141,421 lines, the ratio of the diagonal of a square to one of its sides being 1.41421.

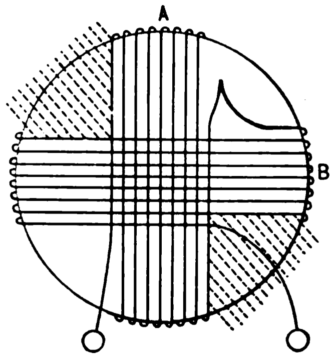


FIG. 3.—COILS 90 DEGREES APART.

Now, if the windings be separated and each winding supplied with a separate alternating current, the two currents differing in phase by a quarter of a cycle, the resultant magnetic field will not remain stationary midway between the two coils, as shown in Fig. 3, but it will rotate just as though it were supplied from a permanent bar magnet pivoted at its center and rotated by some external force. Inspection of Figs. 4 and 5 in connection with Fig. 3 will make this clear. Referring to Fig. 3, it will be evident that the flux produced by the coil, A, alone would have a

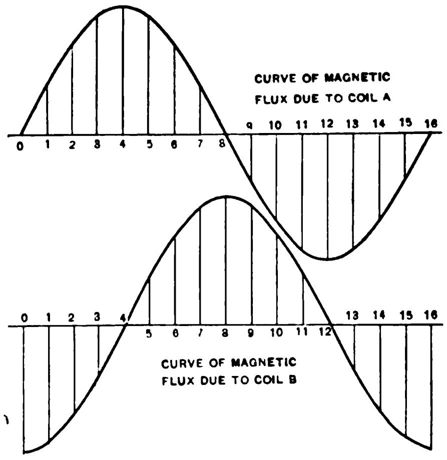


FIG. 4.—TWO-PHASE CURVES.

horizontal direction and would simply vary in strength and alternate in polarity. This flux may be represented, therefore, by a horizontal vector, the length of which represents the strength of the flux at a given instant and the direction its polarity. The flux created by the coil, B, would also vary in strength and alternate in polarity, but its direction would be vertical. This flux may, therefore, be represented by a vertical vector, making the length of the vector indicate the strength of the flux at any given instant and the direction its polarity. Fig. 4 gives a comparison of the strengths of the two fluxes at 16 equidistant instants during one complete cycle. The strength of the flux at each instant is indicated by the length of the vertical lines between the horizontal zero line and the sine curve, in the usual manner.

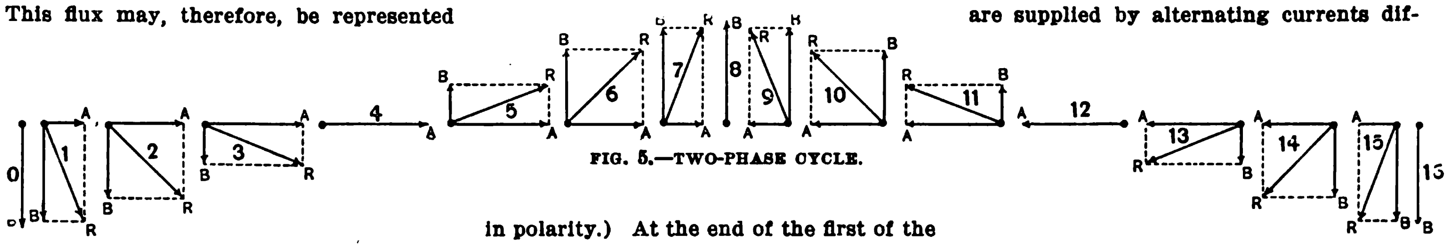


FIG. 5.—TWO-PHASE CYCLE.

In Fig. 5 the strength and polarity of the two fluxes are plotted for each of these 16 intervals of a cycle, and their resultant is also plotted. At the beginning of the cycle the strength of the flux from the coil, A, is zero, and that from the coil, B, is maximum (say, 100,000 lines) in the negative direction. (Assume that in Fig. 3 when the vertical flux passes from the bottom to the top of the core through the coil, B, its polarity is "positive," and when the horizontal flux passes from left to right through the coil, A, it is positive in polarity.) At the end of the first of the 16 intervals of the cycle (Figs. 4 and 5) the flux through A has risen to 38,268 lines, and the flux through B has diminished to 92,388 lines. These fluxes are indicated in Fig. 5 by the vectors, A and B, the resultant of which is the vector, R; if the vectors, A and B, are plotted to scale, the length of R on the same scale will indicate a resultant flux of 100,000 lines; its position, it will be noted, has shifted just 1/16 of a circle from the position of the vector, B, which at the commencement of the cycle was the only flux and therefore identical with R. At the end of the second interval the flux through A has risen to 70,711 lines, and the flux through B has decreased to the same figure. The resultant of these is still 100,000 lines, but the resultant flux has shifted through another 1/16 of the circle. The rotation of this resultant field may be traced throughout Fig. 5, the individual diagrams of which represent the combination of the two fluxes at the sixteen intervals of the cycles; these intervals are indicated by numerals in both Figs. 4 and 5.

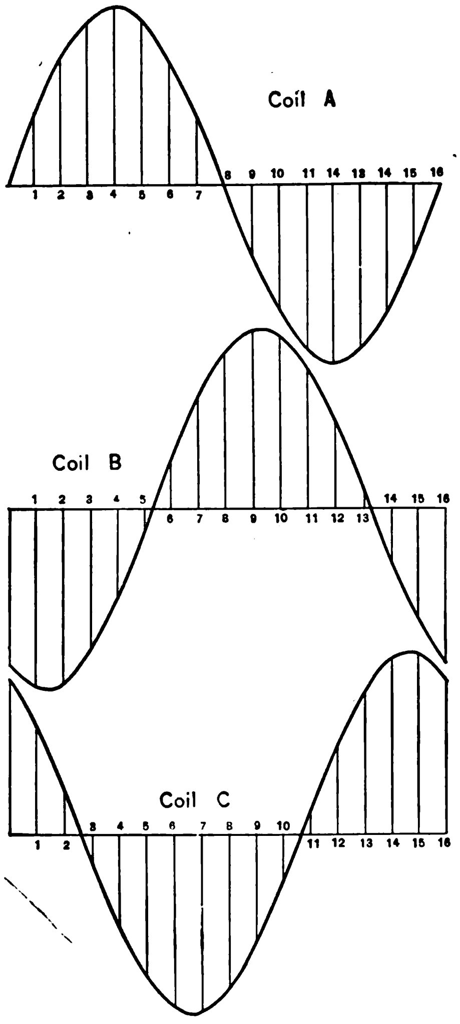


FIG. 6.—THREE-PHASE CURVES.

It will be evident that the length of the vector, R, remains constant throughout, and its position shifts around the circle by intervals corresponding with the intervals of a cycle, so that at the end of one cycle the plane of the result flux, represented by the vector, R, will have made one complete revolution. It will be understood that the rotation of the field will be uniform as to rate, and will not occur in jumps from one position to another, as a too literal interpretation of the diagram might lead a beginner to suppose. The cycle has been divided into 16 steps merely for convenience; but the shifting of the field will be continuous, just as though one divided the cycle into an infinite number of steps.

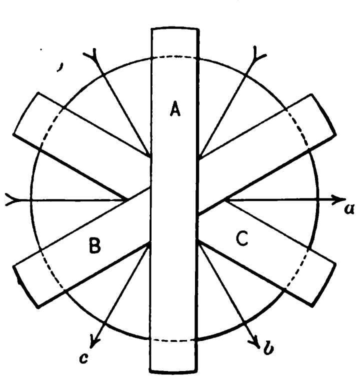


FIG. 7.

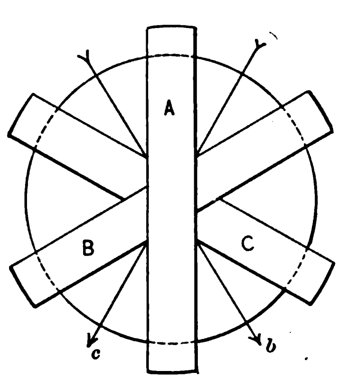


FIG. 8.

The case of a three-phase rotating field is similar but not quite so simple. Fig. 6 shows three curves, representing the rise and fall through one cycle of three magnetic fluxes produced by three coils which are supplied by alternating currents differing in phase by 120°. As in the previous case, the cycle has been divided into 16 equal intervals indicated by numerals. If these three coils be mounted on a single core and displaced angularly 120°, as indicated in Fig. 8, the three-phase currents supplied to them will produce a rotating field just as the two-phase currents did in the two coils previously considered. It will not be necessary to follow through a complete cycle in order to demonstrate this; one-quarter of a cycle will be sufficient.

At the beginning of the cycle the coil, A, produces no flux; we will assume that the current through the coil, B, is in such direction as to produce a flux in the direction of the arrow, *b*, and that the current through the coil, C, produces a flux in the direction indicated by the arrow, *c*. We will also assume that the strength of the flux is proportional to the strength of the current and that the maximum strength of the flux produced by any one coil is 100,000 lines, as before. At the beginning of the cycle all of the flux is due to the coils B and C, which produce each a flux of 86,603 lines. It will be evident upon inspection that the mechanical phase difference (angular displacement) between these two fluxes is only 60°. The combination of the two fluxes is indicated by the extreme left-hand diagram of Fig. 9 (which is marked 0 to correspond with the numbering of the intervals in Fig. 6), where B and C represent the two individual fluxes and R the resultant. This resultant is 150,000 lines.

At the expiration of the first interval of the cycle, the coil, A, produces a magnetic flux from left to right, as indicated by the arrow, *a*, Fig. 7. This flux is indicated in Fig. 9 by the vector, A, and its strength at the end of the first interval is 38,268 lines. The strength of the flux from coil B has increased to 99,144 lines and the strength of the flux from coil C has diminished to 60,876 lines. The resultant of the fluxes, B and C, is indicated by the broken line, *r*. Combining this vector with the vector, A, by the parallelogram law gives the resultant, R, the length of which indicates the flux of 150,000 lines; the direction of the resultant has been shifted 1/16 of a circle. The diagrams marked 2, 3 and 4, in Fig. 9, show the combinations of the three fluxes at the expiration of the second, third and fourth intervals of the cycle, the fourth interval completing a quarter revolution of the field. In each case the resultant of the fluxes, B and C, is indicated by the broken line, *r*, and this is combined with the vector, A, to form the resultant, R, which invariably indicates 150,000 lines of force. Between the second and third intervals the flux from coil C comes to zero and reverses (see lowest curve in Fig. 6); at the expiration of the third interval, therefore, the polarity of this flux will be opposite to its former sign, so that the vector, C, is plotted on the opposite side of the point of origin in diagram No. 3 of Fig. 9. The angular displacement of the two fluxes, B and C, is now 120° instead of 60. At the expiration of the fourth interval the resultant of the fluxes, B and C, is in line with the flux, A, so that it is added directly to it, giving the vector, R. Applying a scale to the diagram will show that the length of the vector, R, has remained constant, the only effect being to shift its position around through one-quarter of a circle.

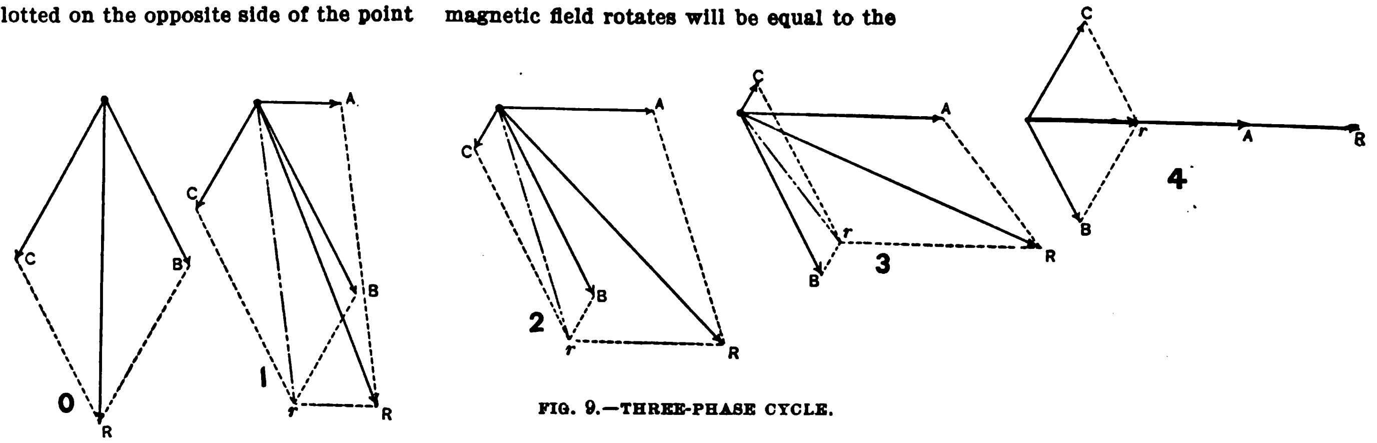


FIG. 9.—THREE-PHASE CYCLE.

The accompanying table gives the instantaneous values of each of the three fluxes through one complete cycle at intervals of 1/16 cycle, together with their polarities, calling the horizontal flux of Fig. 8 positive when its direction is from left to right and the other two fluxes positive when their direction is upward.

Parts of a cycle.	Flux A	Flux B	Flux C	Resultant Flux, 150,000 Lines.
Start	0	86,603 N	86,603 N	Vertical; downward
1/16	38,268 P	99,144 N	60,876 N	22½° from vertical.
2/16	70,711 P	96,593 N	25,882 N	45° from vertical.
3/16	92,388 P	79,335 N	13,053 P	67½° from vertical.
4/16	100,000 P	50,000 N	50,000 P	Horizontal; right
5/16	92,388 P	13,053 N	79,335 P	22½° above horizontal.
6/16	70,711 P	25,882 P	96,593 P	45° above horizontal.
7/16	38,268 P	60,876 P	99,144 P	67½° above horizontal.
8/16	0	86,603 P	86,603 P	Vertical; upward
9/16	38,368 N	99,144 P	60,876 P	22½° from vertical.
10/16	70,711 N	96,593 P	25,882 P	45° from vertical.
11/16	92,388 N	79,335 P	13,053 N	67½° from vertical.
12/16	100,000 N	50,000 P	50,000 N	Horizontal; left
13/16	92,388 N	13,053 P	79,335 N	22½° below horizontal.
14/16	70,711 N	25,882 N	96,593 N	45° below horizontal.
15/16	38,268 N	60,876 N	99,144 N	67½° below horizontal.
End	0	86,603 N	86,603 N	Vertical; downward.

From the foregoing it will be evident that:

(1). If two or more coils, arranged with their centers coincident and their planes displaced until the included angles are all equal, be excited by individual and equal alternating currents which follow the sine law and differ in phase by $\frac{1}{x}$ of a cycle, x being the number of coils, the magnetic fluxes produced by the coils will combine to form a resultant field which will revolve uniformly about the center of the coils in a plane of rotation at right angles with the planes of the coils.

(2). The resultant flux will not be alternating but will remain constant at a magnitude equal to $\frac{x}{2}$ times the *maximum* value of the alternating flux produced by any one coil.

(3). The rate at which the resultant magnetic field rotates will be equal to the frequency of the exciting currents. Thus, 60-cycle currents will cause the field to make 60 revolutions per second (in the elementary case under consideration).

Should the currents not follow the same law or should they be unequal in value, the resultant magnetic flux will not be constant, but will vary between $\frac{x}{2}a$ and $\frac{x}{2}z$, a and z representing the maximum values of the strongest and weakest fluxes respectively, and x, the number of coils. The rotation of the field will also be irregular, being more rapid during some parts of a cycle than during other parts of the same cycle; the average rate, however, will remain identical with the frequency of the exciting currents.

Letters on Practical Subjects

Starting Up Steam Engines.

To the Editor, American Electrician:

Sir:—It is customary with many engineers in starting up an engine, after opening the drip cocks and clearing the water out of the cylinder, to run the engine up to speed with the drip cocks still open. If the drip is delivered into the open air this practice is all right, but where the drips are delivered to a trap or are connected so that their ultimate opening into the atmosphere can be plugged up with the water of condensation, the practice of bringing the engine up to speed with the drip cocks open has been known to cause serious accidents, especially in the case of small high-speed engines. In one case within the writer's observation water was drawn into the front end of the cylinder from the drips and pushed the piston partly off the rod, breaking off the threaded end of the rod on which the piston-head nut was screwed. This broken end consequently fell down between the piston and the back cylinder head and on the return stroke it jammed the piston forward to such an extent that the piston rod buckled inside the cylinder; when the crank went forward the next time, the piston rod followed until the bent portion struck the inner edge of the stuffing box, when, of course, it could go no further, and the engine was brought to a sudden halt. The cylinder head was knocked off by the force of the blow from the piston when the rod was buckled.

The explanation of the origin of the trouble is, that when the engine is turning over slowly with the drips open, if the throttle is opened at all quickly the piston gives a sudden leap, throwing the governor weights out beyond their normal position and entirely closing the valve. The consequence is that on the return stroke the engine takes no steam and the piston forms a partial vacuum in the cylinder, drawing back the water from the drips. With large slow-speed engines, of course, this trouble is not so likely to occur, as the inertia of the moving parts will usually prevent such sudden motion on the part of the piston as to make the governor close the valve entirely, but on medium-size and small engines with shaft governors, the drip cocks should be invariably closed after the cylinder has been cleared of water and before the engine is speeded up. W. C. Townsend.

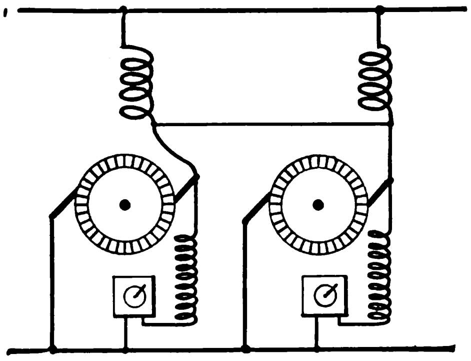
New Orleans, La.

◆

Compound Dynamos in Parallel.

To the Editor, American Electrician;

Sir:—In the latter part of Mr. Parham's article on "Bucking of Railway Generators" last month, the statement is made that if one machine tends to overpower its mate and drive it as a motor, and the two are highly compounded, "the series field of the motored machine may be strong enough to try to reverse the direction of rotation of its armature (since series dynamos run in the opposite direction as motors)." Mr. Parham apparently overlooks the fact that with an equalizer connection between the dynamos it is impossible for one to deliver current backward through the series winding of the other. The accompanying sketch will make this clear. The equalizer puts the series windings in multiple, and the current cannot pass in opposite directions through the two windings. If the statement refers to dynamos without an equalizer, it is a little misleading, because no one would ever attempt to run compound-wound dynamos that way.



GENERATORS WITH EQUALIZER.

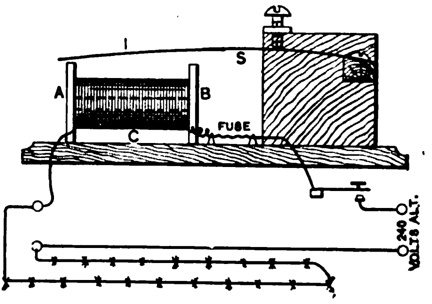
Brooklyn, N. Y. Geo. W. Malcolm.

◆

A Convenient Circuit Tester.

To the Editor, American Electrician;

Sir:—Thinking that some of your readers may be interested in an application of alternating currents for testing lighting circuits both for continuity and for grounds, in place of the familiar magneto which is, as is well known, frequently unreliable, I submit the accompanying arrangement which is used in our plant here. Referring to the engraving, C is an 80-ohm magnet coil with a soft-iron core and two thin projecting pole-pieces, A and B. A thin iron armature, I, is soldered to the end of a brass spring, S, which is mounted at its right-hand end on a wooden cleat on the side of the wooden standard. An adjusting screw is provided in an overhanging brass plate to regulate the distance of the armature, I, from the pole-pieces, A and B. The sketch shows the testing device connected to an arc circuit. On connecting the right-hand terminals to a 240-volt alternating-current circuit and closing the switch, if the arc circuit is intact the spring will be drawn down until it touches the pole-piece, A, and then gives a loud buzzing noise due to the rapid reversal of the alternating current. The spring is adjusted so that the armature cannot touch the pole-piece, B.



CIRCUIT TESTER.

This apparatus has been in use a long time and under varying conditions, and has proved more sensitive than a magneto, especially in testing circuits for grounds. On one particularly wet day all the circuits were tested for grounds with a magneto; no ring whatever was obtained, indicating that the line insulation was at least 30,000 ohms from the ground. On trying the apparatus here shown, one circuit gave a feeble buzz, showing that notwithstanding the magneto test there was a slight ground on that circuit. After setting the armature for testing the continuity of a circuit no further adjustment is necessary in order to detect grounds which a 30,000-ohm magneto will not indicate. The arrangement is also useful, of course, in testing for open circuits and grounds in various pieces of apparatus around a station, such as enclosed fuses, armature and field magnet coils, arc lamps, etc. J. A. Keniston.

Portland, Maine.

◆

Central Station Charging.

To the Editor, American Electrician;

Sir:—In Mr. Henry L. Doherty's paper read before the Northwestern Electrical Association, on the rate question, he says: "In view of the fact that it will be inadvisable to enforce this system on old consumers, who will be injured by its adoption, I propose to adopt it first as a substitute for all special rate consumers and also for new consumers. Instead of dividing my expenses as they exist today and apportioning them among consumers on this basis, I expect to adopt such charges as will benefit the long-hour, and, therefore, the profitable, consumers, to such an extent as can be readily compensated for by the additional business which can be secured with a lower rate per kilowatt-hour. I will continue the rate cutting by small steps so long as I can protect the company's net earnings from marked shrinkage." A system which cannot be put into force without injury to customers must be wrong somewhere. Dividing his expenses as they exist to-day among the customers of a plant that may be ten times too large for their wants, is a feature that would not meet with much success in Massachusetts, for instance, where they have gas and electric-light commissions to protect the interests of the public or patrons of the company. Any discrimination in favor of one set of consumers over another set does not appeal very strongly to the other set in the same class, as the correct thing. It is proper to "protect the company's net earnings," but not at the expense of the old customers entirely.

The idea of charging for the capacity demanded is not new, as witness the Wright demand system, nor is the idea of limiting that demand a new feature, as the Wright demand meter people have advocated that same thing in connection with their plan of charging. That a charge for capacity is entirely proper no one can gainsay.

In the case of Benj. A. Gould *vs.* Edison Electric Illuminating Company in the New York Supreme Court, Judge Beekman said: "Mr. Gould desired 11 lamps, and the court holds that in view of the alleged total additional investment made necessary on the part of the company of at least $220 to comply with the demand the fixed charge ($18 per year) not based on actual consumption was not of itself improper or unreasonable. The customer does not bind himself to use any particular amount of light, so that the return to the company, based on actual consumption, would rest entirely upon his volition, and it would therefore depend upon him whether the service he has required the corporation to be in constant readiness to render is profitable or unprofitable to the latter. But this constant condition of readiness is a necessary and unavoidable obligation, which must be sustained in order to meet instantaneously the demand for light which the consumer is entitled to have at any moment that he wishes it. It thus forms part of the service to be rendered, and is an item properly to be considered when the reasonableness of the charges exacted by the company is called in question."

There is no doubt but that "readiness to serve" forms a part of the service to be rendered, and it ought not to be an impossibility for some one to devise a system that would need no further excuse for its existence. Mr. Doherty acknowledges the weakness of his system by the assertion that it is not advisable to let all customers share alike in dealing with the company, and in presenting a manifestly illegal way of introducing it. The practice of making a fixed charge for capacity demanded has been in vogue in Manchester, England, for years. The system there fixes the charge at $2.10 a month for each kilowatt capacity of load wired up, and there is a *pro rata* charge for all current of three cents per kilowatt-hour. This does not differ materially from the plan proposed by Mr. Doherty, and is manifestly unjust for the same reason—the starting point is wrong. The general argument is good, but the method of developing and putting the system in operation is certainly open to criticism. A device for limiting the number of lamps a customer may use at one time was put on the market some time before Mr. Doherty's plan was made public, and I fail to see why he should claim it as entirely original with him. R. J. P.

An Improvised Booster.

To the Editor, American Electrician;

Sir:—In Ed. S. Morgan's letter in your January issue on "An Improvised Booster," he states that he used a single-pole double-throw switch to cut out the transformer during light load and get rid of core losses. Throwing the switch to the right, as per original diagram (Fig. 1), cuts out the secondary of the transformer so far as its boosting is concerned, but does not get rid of the core loss, as the, transformer is still energized, the primary and secondary windings being connected in series across the line, as shown by Fig. 2. A double-pole double-throw switch connected as shown by Fig. 3 is necessary to cut out the transformer so as to eliminate core losses. The diagram, Fig. 4, was suggested to the writer as being what Mr. Morgan may have intended to draw instead of that shown by Fig. 1. This arrangement, however, is open to the very serious objection that while the switch lever is in transit from one side to the other, being in contact with neither of the jaws, the full line current passes through the secondary winding and induces a disastrously high e.m.f. in the primary winding. This will be apparent when it is remembered that the exciting current of the transformer is only about two per cent of the full current. The ampere turns, therefore, in the secondary winding when the switch lever is free from both contacts, will be about 50 times as great as the normal exciting ampere turns of the transformer. The result will not be 50 times the normal e.m.f. because the magnetic flux will not increase in direct proportion to the ampere turns, but it will increase sufficiently to make the e.m.f. induced in the primary winding dangerously high, and I advise against using this arrangement under any circumstances. C. C. Webster.

Asbury Park, N. J.

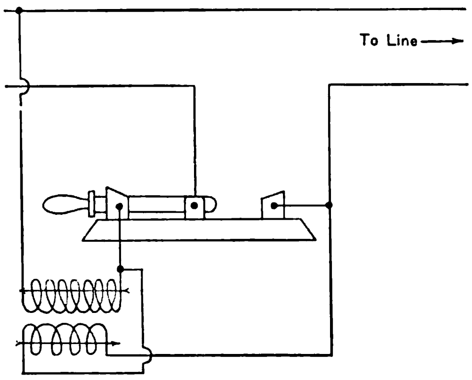


FIG. 1.

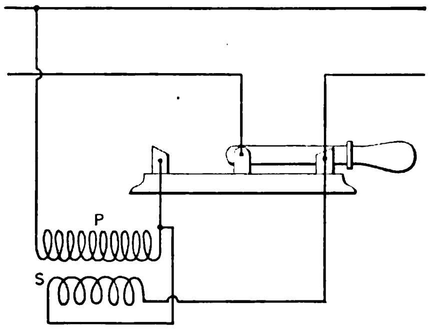


FIG. 2.

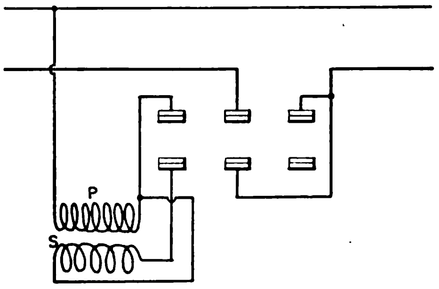


FIG. 3.

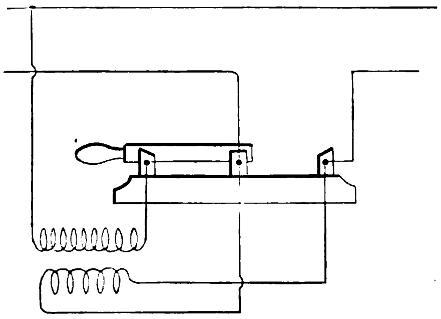


FIG. 4.

To the Editor, American Electrician;

Sir:—In the letter on "An Improvised Booster," in your January issue, a double-throw, single-pole switch is said to be employed to "cut out the booster during light load and get rid of the losses in the core." As the connections were shown, the primary and secondary coils would still be in series, with the switch in the right-hand position, and the core losses would not be appreciably lessened. A double-pole double-throw switch, connected as in the following diagram (Fig. 5), would remedy this difficulty.

Detroit, Mich. H. P. Wood.

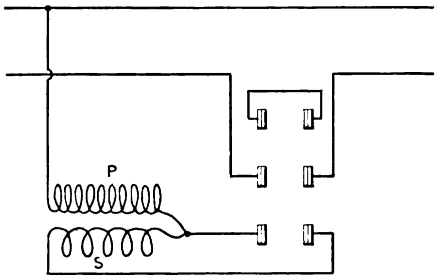


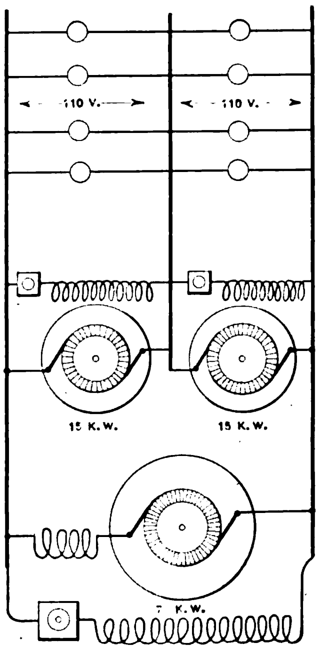
FIG. 5.

A Three-Wire Trouble.

To the Editor, American Electrician;

Sir:—I have been operating two small 110-volt shunt-wound dynamos on the three-wire system and have recently added a larger 220-volt compound-wound machine. When I attempt to operate the three together, connected up as shown by the accompanying diagram, the small machines rob each other and flash violently by turns at the commutator; the action is somewhat similar to that of two badly-adjusted arc lamps in series on a constant-potential circuit. All three dynamos are belt-driven from a single engine. I would be glad if some of your readers could suggest the cause of the trouble and a remedy.

St. Paul, Minn. R. C. Chipman.



THREE-WIRE CONNECTIONS.

Railway Motor Starting Resistance.

To the Editor, American Electrician;

Sir:—Seeing the diagram of controller connections in your last issue brings to mind a point about the connections of the starting resistance that is usually not well understood. As the diagram shows, one-half of the resistance is put in series with the motors when they are thrown in multiple. The object of using only one-half of the resistance is to make the drop in the rheostat the same as when the motors are in series and all of the resistance is in. With the motors in multiple, each one gets only half of the line current, and the total current must be twice as great as on the first notch in order to get the same torque. With twice the current, the rheostat resistance must be only one-half what it was with the motors in series in order to deliver the same e.m.f. at the brushes and keep the current proportional. If the external resistance were the same in both cases, the motors would actually run slower in multiple than in series.

New York. Edward Chilton.

Electrical Catechism

574. How is a water rheostat constructed?

The water may be contained in almost anything convenient, although it is generally safer to use a vessel of insulating material, such as a wooden box or barrel. The electrolyte may be ordinary water when pressures of 500 volts or higher are to be used. It is customary, however, to improve the conductivity of the water by the addition of a little salt or washing soda or a little acid of some kind. A tablespoonful of salt is about enough for a barrel of water when the voltage is 550. More salt should be used for lower voltages. The conductor terminals are usually plates of iron, although almost anything will do. The resistance is regulated by changing the distance between the plates, or the amount of surface of the plates, or by changing the density of the solution, the latter not being easily changed. (See Fig. 1.)

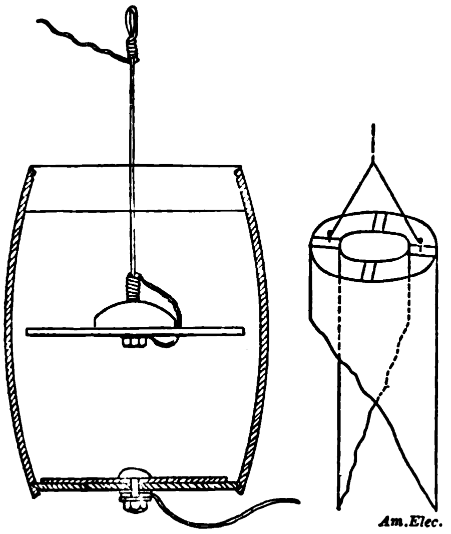


FIG. 1.—WATER RHEOSTAT.—FIG. 2.

575. How are the plates of a water rheostat made?

Two pieces of iron pipe may be fastened to the ends of two sticks and let down into the barrel; or one may be fastened to the side of the barrel and the other be adjustable up and down. The plates may be two tubes or pipes of sheet iron held apart by wooden strips and adjustable up and down by ropes over pulleys as indicated in Fig. 3. When a close adjustment for small currents is desired, the plates may be cut off spirally as suggested in Fig. 2. A convenient plan is to bolt a plate to the bottom of the barrel, being careful to make a tight fit and to paint the lower side well with pitch or asphalt; the upper plate may be a hitching weight to which is screwed a plate with larger surface, the whole being suspended by the conductor, as indicated in Fig. 1.

576. How much energy may be dissipated in a water rheostat?

A barrel containing 50 to 60 gallons will dissipate an equal number of kilowatts. Smaller rheostats sometimes take care of 20 to 150 watts per cubic inch of liquid. The allowable current varies from .25 to 3 amperes per square inch of surface on the exposed face of one electrode.

577. What precautions are desirable in handling water rheostats?

The water should not contain too much salt at first, since the resistance decreases as the temperature rises, and too much current is liable to be the result. The salt should be added from a solution since it takes some time to dissolve and diffuse through the whole body of water; hence the resistance would continue to change for some time after the salt was added. The resistance is most steady when the water is boiling quietly; it takes quite a time before this point is reached, but the time taken to warm up the rheostat is useful in getting everything into working order before the actual test begins. The water rheostat should usually be kept out of doors, unless it is to be used only for a short time, as the fumes are corrosive. Great care should be taken to prevent the plates from making contact with one another, which might cause a short circuit and thus injure the dynamo. In many cases it is also desirable not to ground the circuit, as may easily occur with leaky barrels. There is always more or less risk of getting shocks in adjusting the water rheostat. It is an excellent plan to place the barrel upon timbers, to insulate it from the ground when the water is kept boiling, it is desirable to replenish it more or less continuously, so as to keep the temperature and resistance constant; for this purpose a hose may be attached to the water mains and the valve adjusted to give the right amount of flow; care must be taken against using wire-wound hose, as this might ground the circuit or shock the attendant.

578. How are electric heating and cooking utensils made?

These generally have iron-wire conductors wound upon asbestos or mica. Sometimes the iron wire is woven with asbestos into a sort of cloth. The heat travels through the mica, asbestos and air to the surrounding case, which may be a soldering copper, a flat iron, a cooking utensil or any other desired receiver.

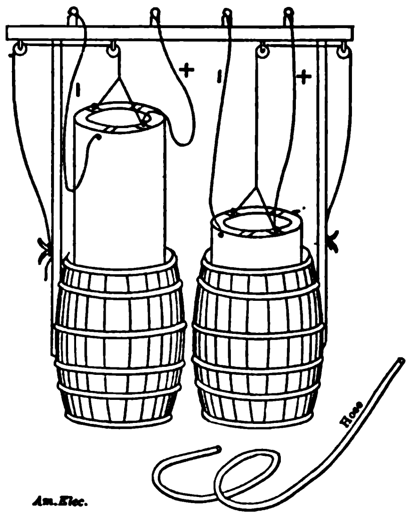


FIG. 3.—PLATES FOR RHEOSTAT.

579. What are the advantages of electrically heated domestic utensils?

The electric irons do not vitiate the atmosphere as do the gas-heated irons, do not allow the starch to stick to the bottoms as they are always at the right temperature and remain highly polished by constant use. The handles are always cool. The cost of operation is found to be less than when heated by gas, and as the resistance is constant, the temperature is always right and uniform, so that they may be used economically and satisfactorily by the most ignorant persons.

FIG. 4.

580. How do surgeons use electric heat?

They use it principally for cautery purposes. Platinum wires are heated by an electric current and applied to parts to be burned off or to be seared. By heating the cautery wire white hot and pressing it against fleshy tissue it acts like a knife and makes a smooth cut. By applying a lower temperature the wire will sear the parts and form a sort of scab for stopping hemorrhages, etc. Cauteries are made in various shapes, some being arranged like a snare to be placed around some undesirable growth which may then be cut off by tightening the loop while the wire is incandescent. Electric cautery is applicable in many places where the knife would be used with great difficulty, and the wounds heal rapidly with less danger from after complications. Cauteries require from 2 to 30 amperes.

FIG. 5.—FLAT IRON.

FIG. 6.—PAD.

581. How do physicians use electric heat?

They use it to some extent for heating poultices and pads to be applied to various parts of the body. They also use it for small incandescent lamps which may be introduced into or near various parts of the body for illuminating purposes.

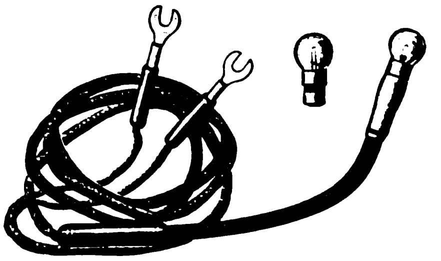


FIG. 7.—PHYSICIAN'S LAMP.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

What size motor will it take to run a screw-cutting lathe with a 9-in. swing? W. H.

One-half horse-power.

What power will the 75-light dynamo described in the January number develop running as a motor? W. S. F.

About 5½ horse-power.

With what size wire should I wind the magnets of a telegraph sounder for maximum strength with two or three gravity batteries? A. L.

No. 24 B. & S. gauge, silk-covered wire.

What is the relative conductivity of carbon and copper? C. W. J.

The conductivity of carbon varies so widely that no fixed ratio can be given. The average ratio, cold, is about 2500 to 1.

What is the approximate e.m.f. required to force a spark through one inch of air space? R. B. K.

Twenty thousand volts, provided the sparking terminals are needle points; otherwise a greater e.m.f. will be required.

A G. E. alternator has a commutator on the shaft in addition to the collector rings. The machine is separately excited. What is the commutator for? L. M. P.

To rectify the main current which passes through the compound windings of the field magnet.

Can I make a transformer to change 110-volts direct current to the amount necessary for operating annunciators and vibrating bells? W. F. G.

No. A transformer is an alternating-current apparatus. You can change the voltage by using either a motor-dynamo or a dynamotor.

What difference does it make whether the primaries of two transformers are connected in series or in parallel, the secondary windings being independent? (2). Does changing the connections between two transformers alter their ratio of transformation? J. L.

When the two primaries are connected in series the e.m.f. of the primary circuit must be twice as great as when they are connected in parallel. (2). No.

What is the cause of an engine exhaust being alternately strong and weak? R. D.

Probably the valve setting is bad, so that steam is cut off much earlier at one end of the cylinder than at the other, giving a higher terminal pressure in the latter end than in the end where the cut-off is earlier.

If an engine running under load at 140 r.p.m. has an additional load thrown on which brings the speed down to, say, 130 r.p.m., will the engine be doing more work at the lower speed than it did at the higher speed? A. S. D.

Ordinarily, no. The fact that the additional load reduces the speed of the engine indicates that the governor has reached its limit and can no longer increase the cut-off of the engine. This being true, the mean-effective pressure on the piston remains unchanged, and as the speed is reduced the output of the engine is also reduced.

How should I rewind a 20-ampere Westinghouse meter built for 140 cycles to run on 60 cycles? (2). If the meter starts up at one-half ampere will it run correct on all other loads? F. V.

Better get the Westinghouse Company to exchange meters; you will find it impossible to rewind your meter properly. (2). Not necessarily.

Can I use No. 12 galvanized wire to carry charging current 1¼ miles from a 110-volt circuit to a 10-volt storage battery plant? (2). The capacity of the battery is 10 amperes; how can I keep the current down to this limit? A. G. S.

No. 12 wire will be too small. Use No. 2, Birmingham gauge, E. B. B. quality. (2). Your current will not exceed 8 amperes. Even with the storage battery cut out and the ends of the line connected together the current would not exceed 10 amperes.

Can two direct-current motors of the same voltage but of different sizes and speeds be belted to the same shaft, provided the pulleys are of the right size? W. J. E.

Yes. It is advisable, however, to calculate the pulleys on the basis of the actual speeds of the motors under full load. Then any discrepancy between the speeds will occur at lesser loads and will result only in dividing the load unequally without harming the motors.

How much resistance is necessary in series with a projector arc lamp for use on a 110-volt circuit, and how is it figured? J. J. T.

Assuming that the lamp is a 10-ampere lamp, the amount of resistance required will be about six ohms. The resistance required can be figured from the formula: $\frac{110 - V}{C} = R$, in which "V" represents the volts required at the terminals of the lamp, "C" is the current which it is to pass, and "R" is the resistance of the coil to be placed in series with it.

How can the losses due to eddy currents and hysteresis in a large armature be ascertained? H. W. A.

Drive the armature perfectly free with the fields unexcited and measure the power required to drive it. Then separately excite the fields to the normal point and drive the armature at the same speed as before measuring the power taken; the difference between the two measurements shows the power absorbed by hysteresis and eddy currents. The brushes must not be allowed to come in contact with the commutator at any time during the test.

Please define the term "phase." (2). What is the difference between a single-phase and a three-phase alternator? (3). What is the ratio between the resistance of platinum wire and that of copper wire of the same size? L. V.

See Lessons Department, February issue. (2). A single-phase alternator delivers a single current; a three-phase alternator delivers three currents which are symmetrically out of phase with each other. (3). Platinum has 5.6 times the resistance of copper.

Please give rules for safe carrying capacity of magnet wire for armature and field windings. A. F.

No rule will apply to all cases. The amount of current a wire will carry is determined by the radiating surface and not directly by the size of the wire. A fair average in practice is to allow 500 circular mils per ampere for amature windings and about 800 or 900 circular mils per ampere for field windings.

Can the dynamo described in the January number be built one-half the size shown, using the same size of wire called for in the article? (2). Can it be operated with two brushes instead of four? E. H. J.

No; if you wish to build a machine of the same type for one-half the output such a design is given in the September, 1900, number. (2). It would hardly be practical to use only one brush on each brush-holder. No machine should have less than two brushes per set so that one brush at a time may be adjusted or changed without shutting down.

What is the formula for calibrating a photometer scale? F. B. R.

The general formula is as follows:

$$L \times \frac{\sqrt{CP}}{\sqrt{S} + \sqrt{CP}} = \text{inches.}$$

In this formula "L" is the distance in inches from lamp to lamp; "S" is the candle-power of the standard lamp used, and "C P" is the candle-power mark on the scale. For a 5-ft. scale and a 16-c.p. standard lamp the formula would read:

$$\frac{60 \times \sqrt{CP}}{4 + \sqrt{CP}} = \text{inches.}$$

What changes and connections are necessary to change the direction of rotation of an alternator? (2). How are the connections made to the commutator of an alternator when there are 10 or 12 segments and only two wires leading from the armature? L. A. V.

If the machine has a rectifying commutator, transpose the cables leading to the brushes of this commutator. The only other change necessary is to turn all the brushes around so that they trail in the opposite direction. (2). One-half of the segments are connected to one wire and the other half to the other wire; every other segment is connected in one group and the alternate segments are connected into the other group.

Please give a simple formula for calculating the ohmic and inductive drop in an alternating-current circuit. G. B.

There is no simple formula for calculating the drop in alternating-current circuits. The formula for single-phase circuits is as follows:

$$\sqrt{(Ep + CR)^2 + (Eq + CX)^2} - E = V.$$

In this formula "E" is the e.m.f. delivered at the far end of the line; "C" is the current; "R" is the resistance of the line; "X" is its reactance; "p" is the power factor of the whole circuit; "q" is the inductance factor of the whole circuit, and "V" is the drop in volts in the line. The drop in a three-phase line may be figured by counting the resistance of only two of the three wires and multiplying the current per wire by 0.87, and using the above formula with the substituted values.

NEW GANG LIGHTNING ARRESTER AND SELF-RESTORING SWITCHBOARD DROP.

The accompanying illustrations, Figs. 1, 2 and 3, represent a form of gang lightning arrester and fuse-holder recently brought out by the Phoenix Electric Telephone Company, New York City, for which application for patents has been made. Fig. 1 represents an outfit for 100 metallic circuit lines, and Fig. 3 shows an equipment for 400 lines, which was installed in a South Carolina exchange, where thunderstorms are unusually severe. The frame work is of iron piping on which are mounted the slate slabs containing the metal work of the arresters. These parts consist, for each line, of two brass plates connected by a fuse link, as shown at the upper part of the right-hand slab in Fig. 3. The left-hand brass plates also contain one terminal of the lightning arrester, and a carbon rod is mounted parallel with the face of the slate and at such a distance from it as to clear the left-hand row of brass plates. The line terminals are connected to the right-hand brass plates, and wires lead from the left-hand plates to the switchboard. The carbon rod parallel with the face of the slate is connected to earth. Fig. 2 shows more clearly the relation of the carbon ground rod to the lightning arrester terminals on the plates. These terminals consist each of a pointed carbon pencil set into the head of a brass screw, which is threaded into the line terminal plate. The distance between the tip of the carbon pencil and the carbon rod is adjustable by turning the brass screw, and a jam nut is provided to hold the screw in any desired position.

Another feature of the Phoenix arrester is that any cleaning that may be necessary between the carbons can be accomplished without resulting in disagreeable and hindering noises in the circuits affected, whereas, it is stated that with the ordinary type of arrester any manipulating gives rise to annoying sounds in the instruments on the lines which are receiving attention. Another advantage possessed by this arrester is that any number of sections may be added from time to time without in the least interfering with those already in service or affecting the switchboard construction or arrangement. In practice, it is stated, the sharp points on the individual carbon tips are not affected by lightning discharges but discharges from heavy-current circuits will pit the ground rod. This trouble is corrected, however, very easily by twisting the ground rod in its socket sufficiently to remove the pitted surface from alignment with the carbon tips and present a fresh smooth surface.

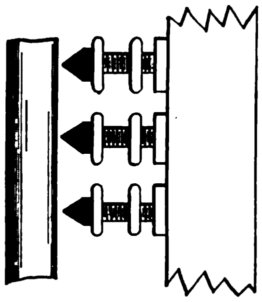


FIG. 2—LIGHTNING ARRESTER TERMINAL.

Fig. 4 illustrates the construction of the Phoenix switchboard drop. The mechanism of the drop is mounted on a hard-rubber disc which in turn is mounted on a wooden panel ⅞ in. thick, made up of five layers of wood put together with the grain running in different directions so as to avoid warping. A section of this wooden panel is shown in the background of the illustration. The drop terminals are two metal prongs arranged to fit into binding posts on the rubber strip at the extreme right of the engraving. In the complete switchboard this rubber strip extends entirely across the back of the board, so that there is no wiring whatever in the interior of the drop sections. The line wires are brought to the two binding posts into which the drop prongs fit. The drops may be removed and inserted, therefore, without disturbing the line wires at all, so that a board may be fitted up with any number of line terminals and equipped with only a portion of the drops without involving any derangement of parts or interference with the existing equipment when additional drops are installed. The drop is a combination drop and jack and is restored by the action of inserting the plug into the jack, which occupies the center of the rubber disc; the plug is inserted through the hole in the drop shutter.

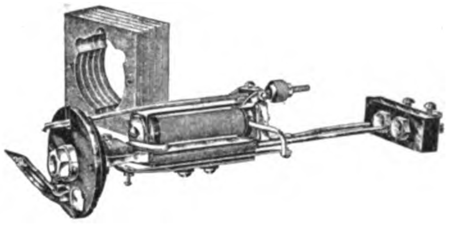


FIG. 4.—SWITCHBOARD DROP.

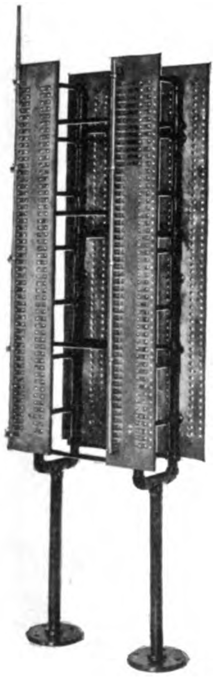


FIG. 1.

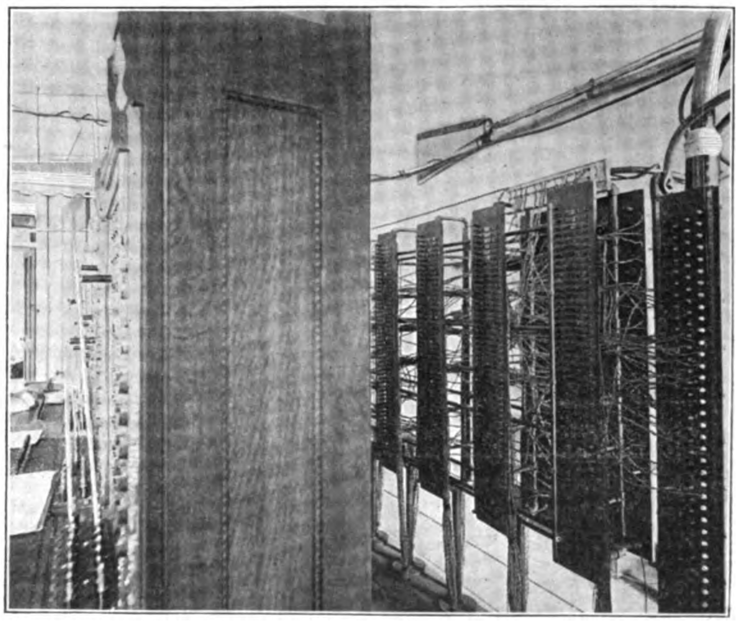


FIG. 3.—LIGHTNING ARRESTERS IN A SOUTH CAROLINA EXCHANGE.

"SOLID" TELEPHONE RECEIVER.

A unique form of telephone receiver has just been introduced by William J. Murdock & Co., of Chelsea, Mass., under the name of the "Solid" receiver. It is illustrated in cross-section by Fig. 1. The distinctive feature of this receiver is that the magnet, the pole-pieces, the binding posts, the wires connecting with the binding posts and extending through the case and the supporting rings, are covered with the insulating material which forms the case and are solidly moulded therein, making the case and all these

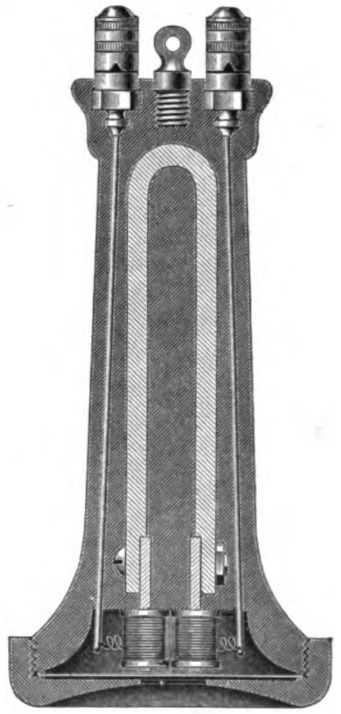


FIG. 1.—"SOLID" TELEPHONE RECEIVER.

parts practically one piece. This gives the magnet a permanent position, and keeps the pole-pieces always in the same relative position with respect to the diaphragm seat. The binding posts are made hexagonal in shape and grooved, this shape preventing their turning; the grooves insure them against pulling out of the moulded case. The claims of the manufacturers are that the adjustment of their receivers being exact on the outset, this construction makes it permanently so.

EUREKA TELEPHONE SWITCHBOARD.

The accompanying illustrations represent a 1000-line express switchboard built by the Eureka Electric Company, of Chicago, Ill., and two of its individual devices. The board here illustrated is equipped with supervisory flash-light signal, trunking and transfer systems, and self-restoring line drops. Like all of the Eureka boards, this one is built in 100-line sections or frames, and arranged so that by removing the molding from one end of the cabinet additional sections or frames can be added side by side, the molding being replaced on the last section added. Each 100-line section is provided with the usual operator's equipment of transmitter, head receiver, and 10 pairs of plugs with reinforced cords, together with self-contained clearing-out drops and operator's cams. One of these self-contained clearing-out drops with its cam switch is illustrated by Fig. 2; this device contributes greatly to the simplicity of the system. The line drops and jacks are the combination type, and can be removed and replaced on the board without disturbing any line connections or using tools of any sort. The line-drop shutter falls sidewise instead of away from the board, as most drops fall, and the restoration of the drop is accomplished by the insertion of the plug in the jack. The shutter does not cover the line jack socket, as is the case in most plug-restoring drops; the restoration is done by an auxiliary lever which is thrown up by the insertion of the plug in the jack socket and resets the shutter through the medium of a finger at the rear end of the shutter pivot. A back view of the combined drop and jack is shown by Fig. 3, and will make this description clear.

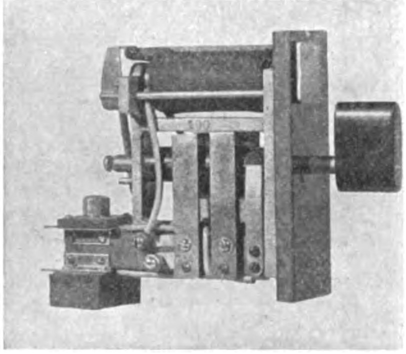


FIG. 2—SELF-CONTAINED CAM AND CLEARING-OUT DROP.

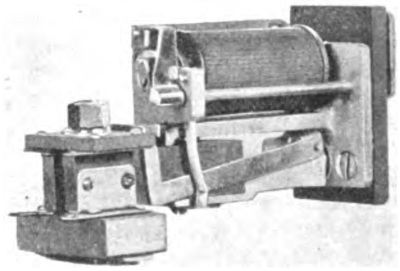


FIG. 3.—METALLIC DROP, SHOWING RESTORER.

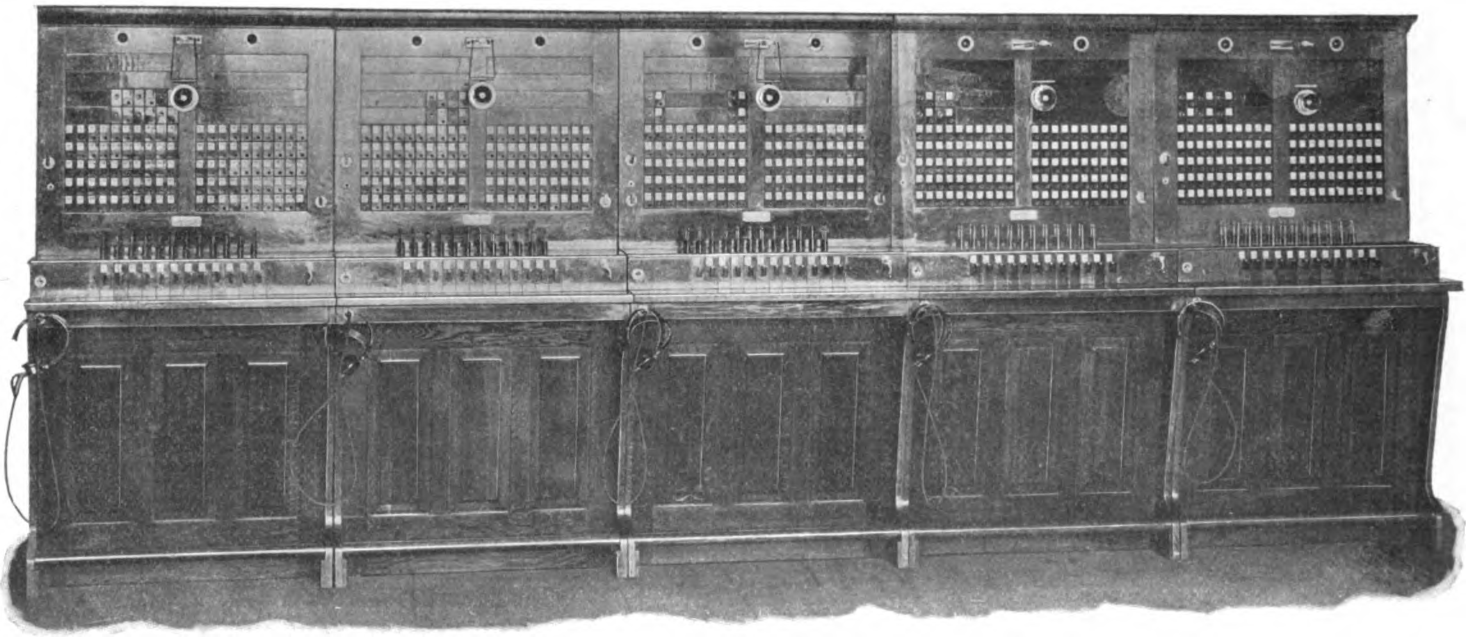


FIG. 1.—TELEPHONE SWITCHBOARD WITH PILOT FLASH LIGHT, TRUNKING AND TRANSFER SYSTEMS.

The form of combined listening and ringing key which is usually employed in switchboard work independently of the clearing-out drop is not used here. After a call has been made and the operator has inserted the answering plug in the line jack, restoring the shutter, the operator's set is in connection with the subscriber making the call without the use of a listening cam. After learning the number desired, the operator inserts the second plug in the line jack of the desired subscriber in the usual way, connecting the two subscribers through the cord circuit. Then the operator's cam is moved over to the left and rings up the subscriber wanted without ringing back into the first subscriber's line. (Ringing back is accomplished by throwing the cam over to the right.) The movement of the cam from its central position also cuts out the operator's set from the cord circuit. At any time that it may be desirable to cut in the operator's set on the cord circuit all that is necessary is to return the cam to its normal midway position. When the plugs are inserted in the jacks the main-line drops are cut out and the automatic clearing-out drop, which has a high-impedance bridging winding, is cut in. When a subscriber finishes talking, and rings off, the clearing-out drop is thrown, and the operator restores the cam to its normal position, which movement automatically restores the clearing-out drop. The clearing-out drop is mounted along with the operator's cam in a hard-rubber case, and is readily removable and replaceable, like the combination line drops and jacks. The features of the mechanical construction of the various parts are strength and the utmost simplicity. Each line drop, for example, contains only a single spring, namely, the tip spring. The switchboard is arranged so that the pilot-lamp system can be installed at any time on any 100-line section, and it is provided with circuit-changing switches actuated by draw-knobs, by means of which the operator may change the ringing circuit from the hand to the power generator and also cut on and off the auxiliary night-bell circuit.

THE STROUD TOLL-SERVICE RECORDER.

A simple system for recording the number of calls made at telephone toll stations has been brought out by the National Measured Service Company, Chicago, Ill. Figs. 1 and 2 herewith illustrate the essential apparatus of the system. At the subscriber's station a small auxiliary instrument shown by Fig. 1, is installed. In calling up, the subscriber presses the button in the top of the case, which notifies the exchange operator of the call. This call is registered by the dial wheels in the instrument, and is also "stored" by clock-work mechanism within the meter. At the end of a certain period, say once a month, when it is required to take readings of the various meters, the central office operator calls up each subscriber and asks him to press the button just as in signalling for ordinary connection. The circuits, however, are so arranged this time that this call does not count against the subscriber but merely starts the mechanism of the record-taker; shown in Fig. 2, which instrument is located at the exchange. The mechanism of the record-taker then reproduces the total number of calls stored in the meter at the subscriber's station. The face of the meter at the subscriber's station shows all the calls from the time the meter is installed up to 9999, and then reverts to zero. The central office machine takes the statement since the last reading and is then turned back to zero, so that the total calls on the face of the meter at the subscriber's station should correspond with the number of calls shown by the books of the company added to the last reading of the record-taker. The meter at the subscriber's station is sealed so that it cannot be deranged or tampered with, and both of the machines are very substantially built. It is stated that one or two portable record-takers will suffice for the work of an entire exchange. The advantage of the instrument obviously lies in the fact that it saves the time and expense of sending an attendant around to take the readings of the various meters.

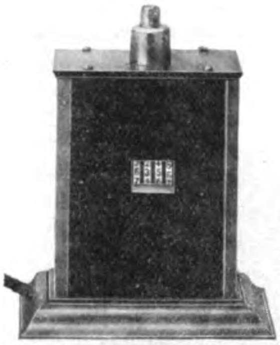


FIG. 1.—METER.

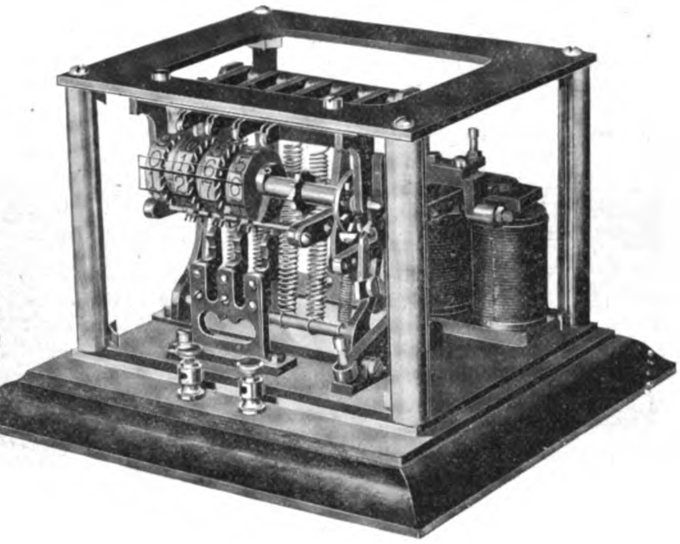


FIG. 2.- RECORD TAKER.

CLARKE AUTOMATIC TELEPHONE SYSTEM.

The accompanying engravings, Figs. 1 to 4, inclusive, are illustrative of a new automatic telephone switchboard system manufactured by the Clarke Automatic Telephone Switchboard Company, of Providence, R. I., and especially designed for use in mills, factories, mines, warehouses, offices and small towns. The Standard desk telephone having the Clarke dial for a base is shown in Fig. 1, and a switchboard wired for twelve telephones, and having the front and back removed, is illustrated by Fig. 3. The Clarke dial and automatic switch are illustrated by Figs. 2 and 4. The dial case, which forms the base of the desk outfit and is mounted alongside the wall outfit, contains a clock-work mechanism consisting of two brass wheels having 75 teeth, each mounted on a central axle with a smaller wheel, the latter engaging a retarding mechanism which regulates the speed of rotation of the lower of the two main wheels. This mechanism is mounted on a cast-iron base and covered by a nickel case. On the side of the case is a small plunger which engages a locking lever. The top wheel on the spindle acts as a dummy and is used to store power in a spiral spring for operating the lower wheel, the two being connected only by this spring. The operation is as follows:

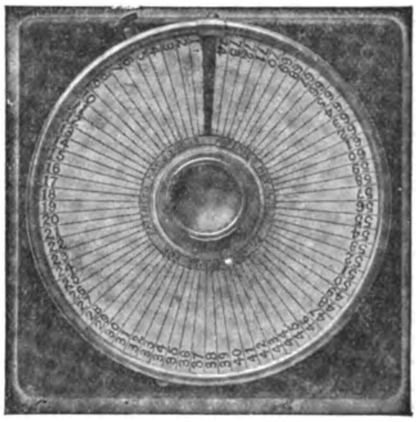


FIG. 2.—SUBSCRIBER'S DIAL.

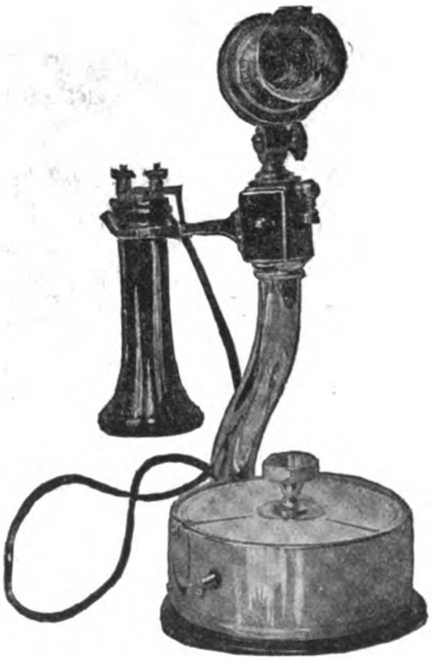


FIG. 1 —DESK OUTFIT.

The locking lever is held normally by means of a small spring so that it engages the dummy wheel, which is prevented by a pawl from any backward motion after a tooth on this wheel has once passed the pawl. On pushing the plunger in, the dummy wheel is released from the locking lever and at the same time the lower wheel is locked. It is then possible to turn the dummy forward by means of the knob on the axle, thereby storing up power in the clock spring, and setting the dial to whatever number it is desired to call. The numbers 1 to 75 appear on a disc, which is mounted on the central axle and turns with the dummy wheel, the pointer being stationary and fastened on the nickel case. On releasing the plunger the dummy wheel is again locked and the spiral spring pulls the lower wheel forward until a pin on its rim engages a pin on the rim of the dummy wheel, this being the normal relation of the two wheels. For example, if the dummy be turned forward seven teeth, then the lower wheel will be moved forward seven teeth by the coil spring. Mounted on a red fiber block is a small contact spring which is set so that its point normally rests between two teeth on the lower wheel and touches each tooth as the wheel is turned forward. The making of the contact serves to close an electric circuit through a magnet mounted on the automatic switch.

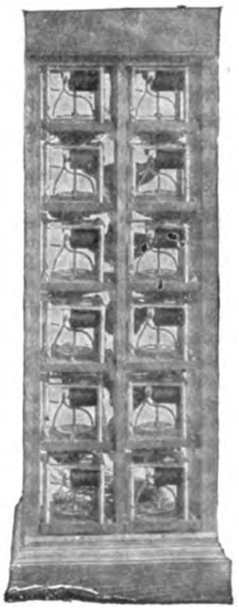


FIG. 3 —SWITCHBOARD.

The automatic switch consists of a small red fiber base, having 75 contact points mounted on it in a circle, each being the terminal of a subscriber's line. Four upright posts support a top frame on which is mounted a magnet, whose armature is mounted on one end of a lever, the other end of which is bifurcated and engages a wheel mounted on a spindle; a spring attached to this wheel makes a sliding connection with each of the contact points in turn as it passes them. Each impulse sent through the magnet by the dial at the subscriber's station causes the switch wheel to turn 1/75 of a revolution; as the teeth on the switch wheel correspond in number to the teeth on the dial wheel and the number of contact points on the base of the switch, the contact spring of the switch wheel will evidently be brought into contact with any subscriber's line by setting the dial to the number corresponding to the subscriber's number.

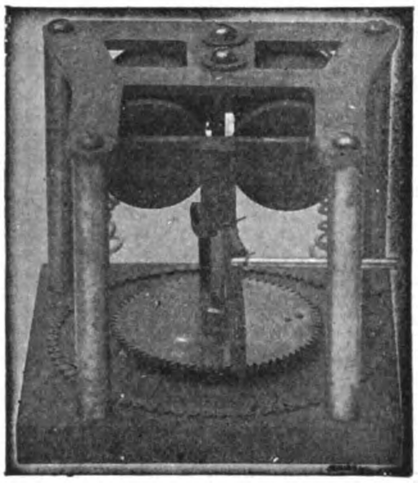


FIG. 4.—AUTOMATIC SWITCH.

◆◆◆

A NEW SHELL-TYPE TRANSFORMER.

The relative merits of core-type and shell-type transformer construction have been the subject of much discussion and contention, some manufacturers favoring the one, while others declare that the other is greatly preferable. Advocates of the core-type transformer argue that the greater area of exposed coil surface is an advantage which overweighs the advantages embodied in the shell-type construction. On the other hand, shell-type advocates insist that the core-type transformer is at a disadvantage because the most of its core is covered with windings. Among the latter advocates is the Fort Wayne Electric Works, Fort Wayne, Ind., who has steadfastly adhered to the shell-type form.

One of the disadvantages of the shell-type transformer from a manufacturer's standpoint has been the waste of the material cut out from the core for the reception of the winding. Mr. Jas. J. Wood, of the Fort Wayne Company, overcomes this disadvantage by the use of a peculiarly-shaped core plate, illustrated by Fig. 1. This core plate is stamped in two pieces which dove-tail into each other. If the reader will imagine the right-hand half of the core plate shifted upward until its center tongue touches the upper tongue of the left-hand half, it will be seen that the two can be closed in together without leaving any open spaces. Fig. 3 shows the complete core and coils assembled, and Fig. 2 is a cross-section of the transformer taken parallel with the core plates. It will be noticed that the primary winding is divided into two parts and the secondary winding into four parts, each half of the primary winding being sandwiched between two of the secondary sections. The object of this arrangement is, of course, to reduce magnetic leakage to the lowest possible extent. The coils are machine-wound, of course, and the transformer is designed for oil insulation. A crevice is left, therefore, between the two halves of the total winding for the circulation of oil.

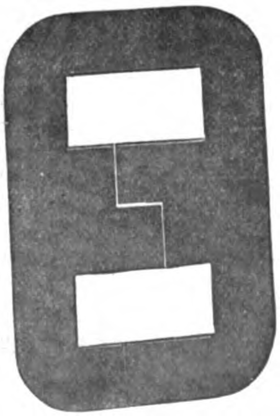


FIG. I.—TRANSFORMER PLATE.

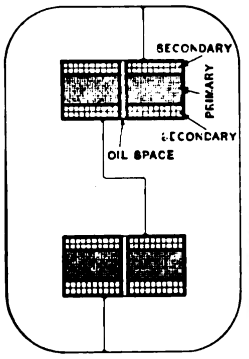


FIG. 2.—CROSS-SECTION.

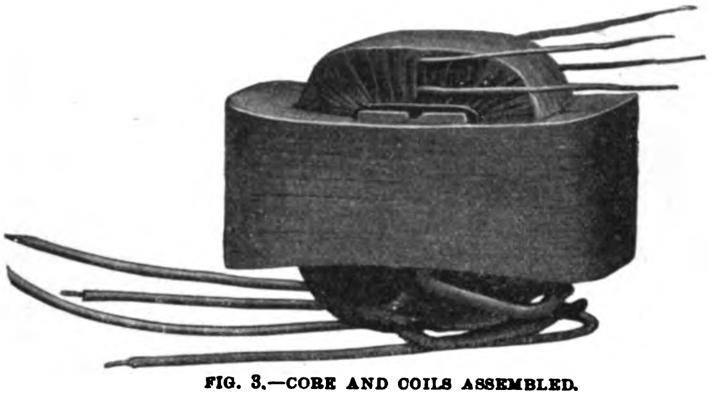


FIG. 3.—CORE AND COILS ASSEMBLED.

Fig. 4 illustrates the method of hanging the transformer; the hanging irons are provided with strong buttons, the shanks of which slip into the U-shaped slots on the casing, the heads occupying recesses beneath the overhanging plates in which the ∩-shaped slots are made. The transformers are built for the usual ranges of voltage.

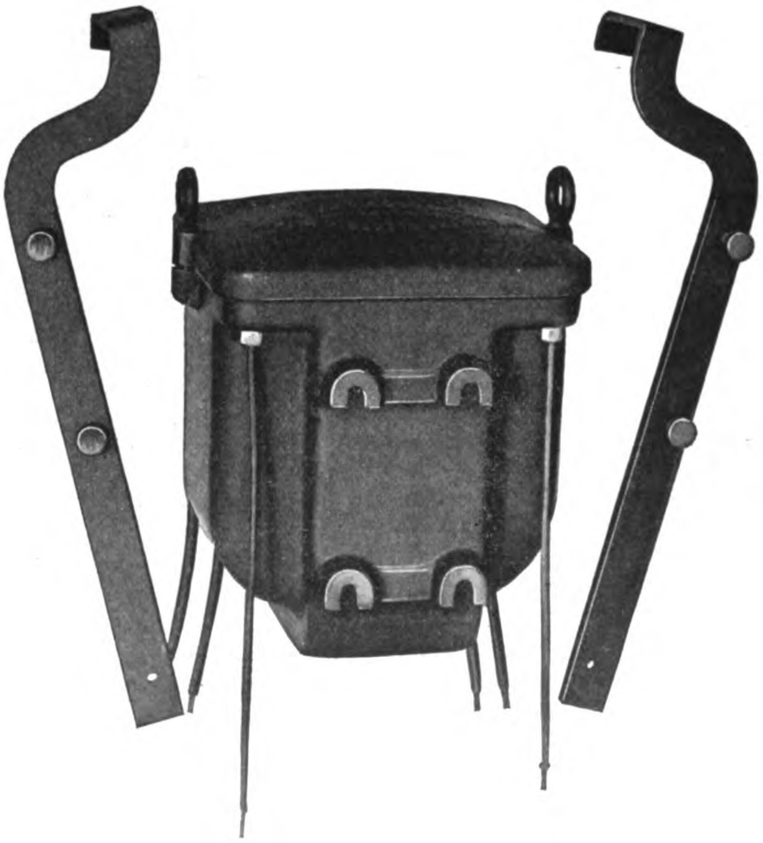


FIG. 4.—REAR VIEW OF 5-KW. TRANSFORMER SHOWING HANGER IRONS DETACHED.

New Apparatus and Appliances

A NEW TYPE OF EXTENSION BELL.

There are places where the ordinary type of telephone extension bell is considered too bulky and too awkward in appearance to be desirable. To meet objections of this sort the Holtzer-Cabot Electric Company, of Brookline, Mass., has put on the market the form of extension bell illustrated by Fig. 1. The cover is shown transparent in the engraving in order to show the arrangement of the internal parts, but it will be understood, of course, that it is an ordinary wooden cover, similar to that of the familiar box bell used in connection with battery service. The magnets and mechanism are the same as those used in the standard Holtzer-Cabot ringers, and are provided with the same means for rapid and accurate adjustment. The magnets are wound for either series or bridging work, and are fully as sensitive as the usual form of extension bell.

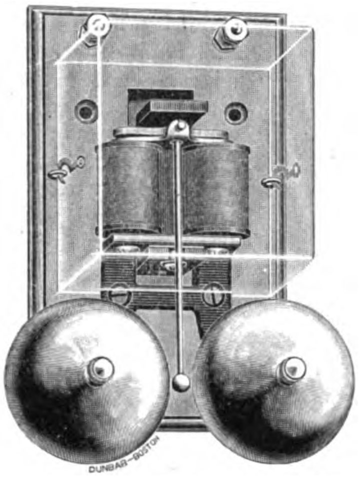


FIG. 1.—EXTENSION BELL.

The Holtzer-Cabot Company is also putting out a neat form of double-pole telephone receiver, which is said to embody several new features. One of these is the manner of adjusting the cord terminals; another is the shape of the pole-pieces, which are plane on the sides facing each other and convex on the outer sides. Fig. 2 shows the field set up at the poles of the receiver, as indicated by iron filings sifted on a piece of paper which was substituted for the diaphragm. The claim of superiority is based on the fact that the outer curves of the pole-pieces are normal to the natural path of the magnetic lines.

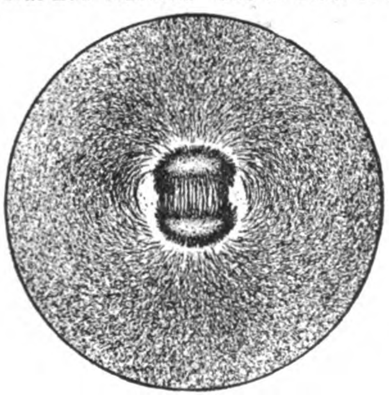


FIG. 2.—FIELD OF RECEIVER.

NATIONAL AUTOMATIC TELEPHONE EXCHANGE SWITCH.

Fig. 3 illustrates the principal feature of the latest form of automatic telephone exchange switch brought out by the National Automatic Telephone Company, Chicago, Ill. The subject of the illustration is what is known as "Automatic Switch No. 3." The exchange is equipped with one of these switches for each subscriber's line. The switch is a step-by-step arrangement with a gravity release, and is very simple in construction and operation. Each subscriber's telephone set, in addition to the usual signalling magneto, is provided with a push-button and dial switch, the numbers on the dial switch extending up to 99. In operation the subscriber takes down the receiver, presses the push-button the number of times that there are hundreds in the desired subscriber's number, turns the dial switch to the number of tens and units in the subscriber's number, and then rings up in the usual manner. For example, if the subscriber who is wanted is No. 216, the calling subscriber presses his push-button twice for the first figure of the number and then turns the dial switch to 16; then turning the magnetic handle will call up subscriber No. 216. The dial switch is constructed to send an impulse over the line for each number that its pointer passes. For example, in turning the pointer to No. 16, the switch will send 16 impulses over the line. These impulses operate a step-by-step mechanism which carries a contact finger around to the proper contact for the desired subscriber. The "hundreds" push-button sends impulses over a separate line, designated the "hundreds" line; these impulses operate a step-by-step mechanism like that before mentioned and which co-operates with the tens-and-units mechanism to establish the proper connection. The automatic switches at the exchange are provided with lock-out arrangements so that if a subscriber's line is busy and another subscriber attempts to call up, the connection already existing will not be disturbed.

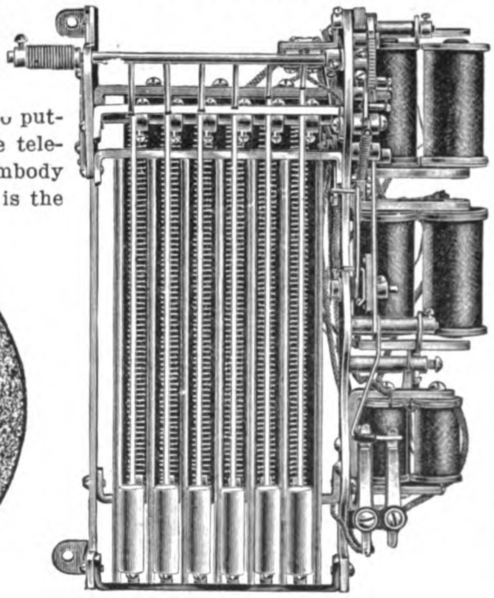


FIG. 3.—AUTOMATIC TELEPHONE SWITCH.

A NEW DOUBLE-POLE TELEPHONE RECEIVER.

Figs. 4 and 5 illustrate the latest type of double-pole and telephone receiver made by the Lambert-Schmidt Telephone Manufacturing Company, of New York. The magnet is of special Wolfram steel, highly saturated and horse-shoe shaped, with broad coils at the poles. These coils have the usual soft iron cores and are wound with silk-insulated wire. At the intersection of the bobbins with the magnet is set a disc of brass for fastening the magnet to the outside shell. The receiver case consists of a heavy brass cup at the head, the handle being one piece of hard rubber covering the body of the magnet and threaded on the inner surface at the open end; this handle is screwed to a tubular projection on the under side of the metal cup. The magnet itself is fastened to the brass cup by two machine screws extending through the brass disc above mentioned, these screws projecting into the rubber shell to prevent this shell from twisting. By this design, the metal cup and the magnet become one solid structure and the contraction, expansion or breakage of the rubber shell does not change the relative position of the magnet poles to the diaphragm. The diaphragm is tinplated soft iron lying evenly on the metal cup. The receiver cap is hard rubber, shaped to clamp the diaphragm at exactly the same point with the edge of the metal case. The binding posts are peculiarly constructed. The body is an arch

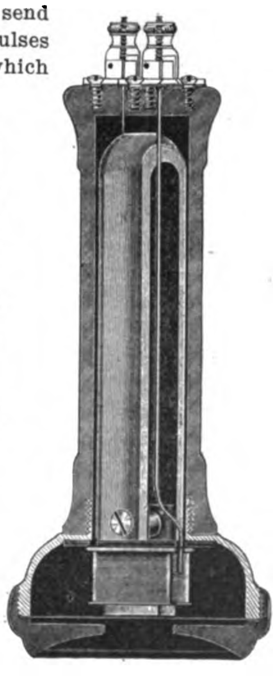


FIG. 4.—DOUBLE-POLE TELEPHONE RECEIVER.—

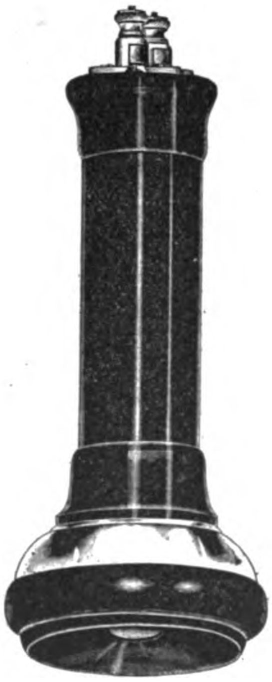


FIG. 5.

with a partially flat top; inside the arch is a square block not filling the entire space and with a long-threaded pin extending through a hole at the top of the arch, but not screwed to it; the pin fits loosely in this hole. A finger nut is screwed to this pin and is located directly over the arch. On the opposite sides of the arch are two small holes; there is also a similar hole through the metal block. The block is brought into position so that these three holes are in alignment and the cord tip is then pushed through. The finger nut is turned, thus drawing up the block and clamping the cord tip on each side of the arch so that it cannot possibly work loose.

A 30-DROP DESK TELEPHONE SWITCHBOARD.

The compact and ornamental desk switchboard illustrated by Fig. 8 is manufactured by the Haines & Noyes Company, of Chicago, Ill., and embodies several features of interest. The switchboard is of the express type, equipped with plug-restoring drops and combined listening and ringing keys with auxiliary ring back. The drops are of the combined jack and drop type, in which the shutter is restored by the action of inserting the plug in the jack. Fig. 9 shows the jack with the shutter down, and Fig. 6 shows it with the shutter restored by the insertion of the plug. This drop differs mechanically from most others in that the shutter instead of falling outward falls sidewise, being mounted on a pivot parallel with the magnet. In restoring it by the movement of the plug, therefore, the plug is pressed against the shutter sidewise, giving a sort of sliding cam action. The combined drops and jacks are mounted on independent face plates and can be removed from the switchboard by simply taking off the two thumb screws at the back. The combined cam and listening key with ring-back key is illustrated by Fig. 7. This does not differ radically from the ordinary type of combination key, the movement of the main lever in one direction serving to make the listening connection and in the opposite direction to ring up the desired subscriber. All of the springs are of German silver with rubbing contacts, tending to keep the contacts bright. All of the wiring is soldered without acid and is readily accessible by removing the back panels of the switchboard. The clearing-out drops are of the tubular type bridged across the cord circuit and the operator's equipment comprises the usual long-distance instruments.

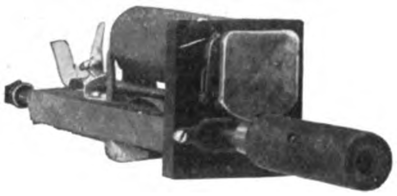


FIG. 6.—DROP RESTORED.

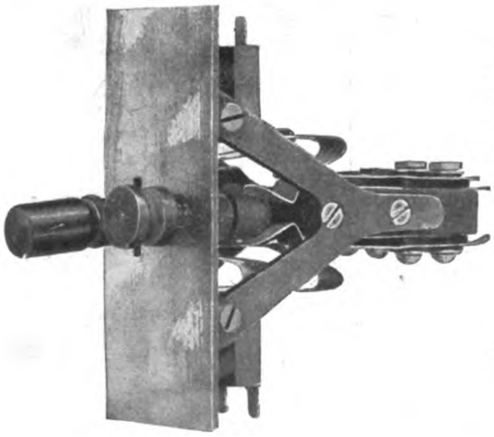


FIG. 7.—CAM, LISTENING KEY AND RING BACK.

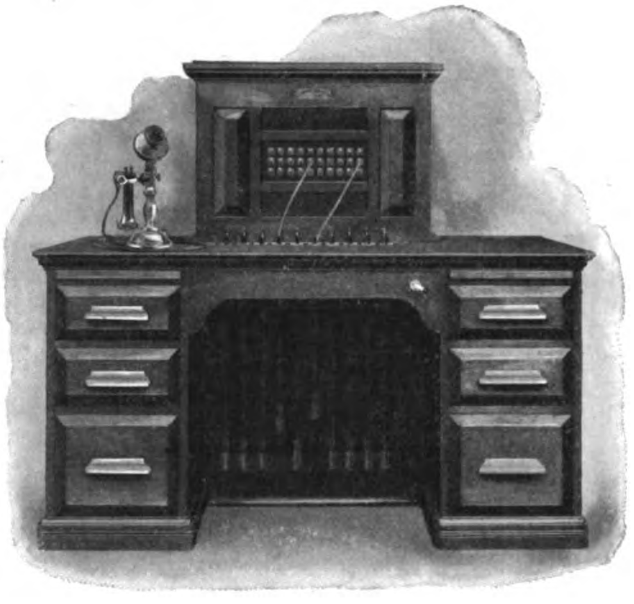


FIG. 8.—30-DROP DESK SWITCHBOARD.

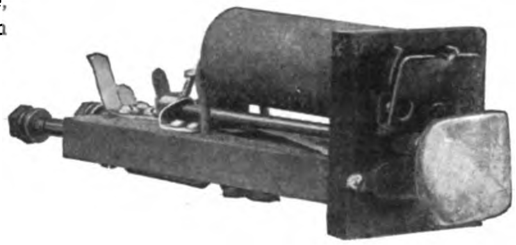


FIG. 9.—DROP DOWN.

COMBINED JACK AND TUBULAR DROP.

The subject of Fig. 10 is the No. 40 combined jack and tubular drop of the Couch & Seeley Company, Boston, Mass. Referring to the engraving, *A* is the tube enclosing the magnet coil, the core of which is screwed at one end to the closed end of the tube; the other end forms one pole of the magnet, and the rim of the open end of the tube, the opposite pole.

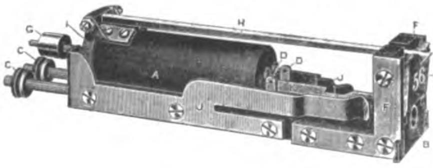


FIG. 10.—JACK AND TUBULAR DROP.

The ends of the windings of the magnet are brought through rubber bushings in the tube and soldered to the tags of drop-springs, *d*, *d*, which are in connection with the line-springs, *j*, *j*, when drop is in normal condition. The line terminals are shown at *c*, *c*. When plug is inserted at *b* into the jack-frame, *k*, the line-springs, *j*, *j*, are separated from the drop-springs, *d*, *d*, thus cutting the drop entirely out of circuit. The shutter, *e*, has two spurs, one on each side, formed at right-angles with its face, and when it falls these spurs come in contact with night-alarm springs fastened to the side pieces, *f*, *f*. The side pieces are of brass, and carry the night-alarm circuit to the upright brass bars notched out to receive the drops when mounted up in regular form in a complete switchboard. The wiring of the complete board using this drop is, therefore, practically done when the drops are set in place. The armature, *i*, is provided with the counter weight, *g*. A very close and sensitive adjustment can be made in the single drop. Current furnished by an ordinary three-bar generator will throw the shutter on a bridging line with a 25-ohm shunt.

D. & W. TELEPHONE PROTECTOR.

A suitable protector for telephone circuits must provide an easy path to earth for the static discharge of lightning and must be provided with a fuse capable of rupturing the circuit upon the passage of heavy current due to a cross with a power or lighting circuit; it must also be so sensitive that it will operate in the case of an imperfect cross with a heavy-current circuit, resulting in what are usually known as "sneak" currents, which, while not large enough to create any instantaneous damage, will ultimately destroy the delicate telephone apparatus. Fig. 11 illustrates a protector made by the D. & W. Fuse Company, Providence, R. I., which is said to fulfill all these requirements, and Fig. 12 is a diagrammatic illustration of the device. It consists of a high-tension enclosed fuse connected in series with a sneak coil, as indicated by the dotted lines. The double-pole arrangement comprises two fuses and sneak coils. The lower terminal of each sneak coil is also connected to

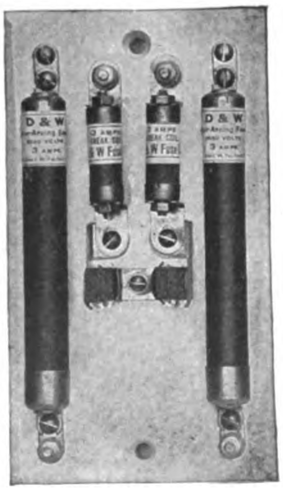


FIG. 11.—TELEPHONE PROTECTOR.

a carbon lightning arrester consisting of two carbon blocks separated by mica. The fuse is of the familiar D. & W. non-arcing type, and is said to be capable of handling a current due to a short-circuit on a 2400-volt alternating circuit without an arc or a flash. The sneak coils are supplied to operate at any desired point from 1/10 ampere up, but the manufacturers recommend for telephone service a 2/10-ampere coil which will operate at 3/10 ampere in less than 15 seconds. Under ordinary conditions the sneak coil alone serves to protect the apparatus, as trouble due to slight crosses between outdoor circuits is more common than a dead cross. Resetting tools are furnished with the protector, by means of which the sneak coils may be easily repaired at slight cost. The device is also made in single-pole form, consisting simply of one-half of the arrangement here illustrated.

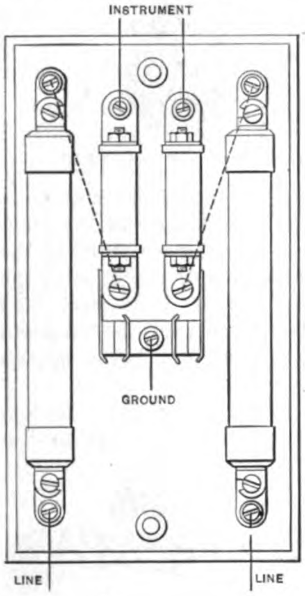


FIG. 12.—CONNECTIONS.

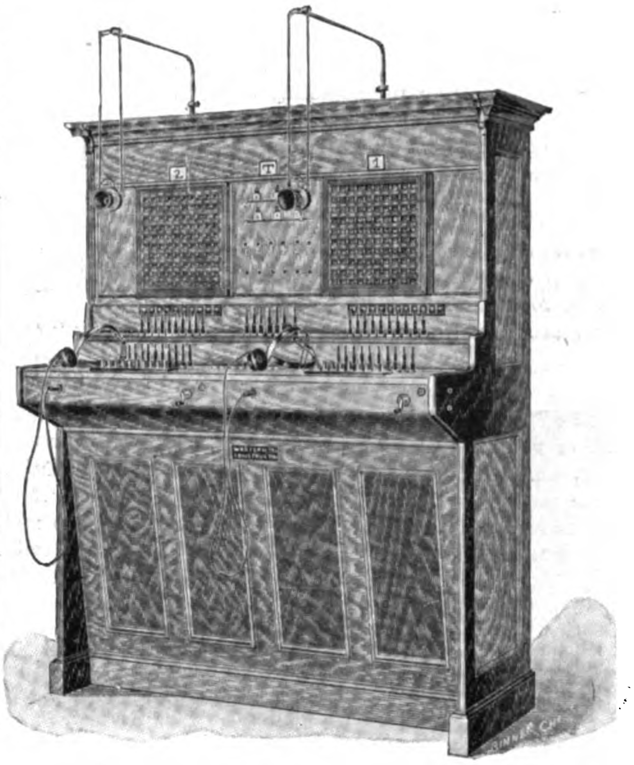


FIG. 14.—EXCHANGE AND TOLL LINE SWITCHBOARD.

COMBINED EXCHANGE AND TOLL-LINE SWITCHBOARD.

Fig. 14 illustrates a very convenient combination of exchange and toll-line switchboard for exchanges of moderate size, which is being supplied by the Western Telephone Construction Company, of Chicago. The arrangement consists of two standard exchange boards of 100 drops each, between which is interposed a six-drop toll-line board. The exchange switchboard can be wired either for all metallic circuits, common-return or grounded circuits, or for any combination of these systems. The jacks and drops are self-contained, and the drop plug restoring. Any jack or drop or coil can be removed and renewed without disconnecting the wiring or interfering with any other connection on the board. Fig. 13 illustrates the combined spring jack and plug-restoring drop. The jack consists of a solid brass casting, A, bored for the reception of the plug, as indicated at N, and mounted on a rubber base, M, along with the magnet and drop; the jack spring is located at F. The magnet, I, has its armature pivoted at C. The finger, H, constitutes the latch which holds and releases the shutter, E. When the subscriber calls up, the finger, H, which is an extension of the magnet armature, releases the drop, E, the latter falling in front of the plug socket in the jack; consequently, in order for the operator to insert the answering plug in the jack she must first raise the shutter or drop and restore it, to clear the jack for insertion of the plug; this is done, of course, by the movement of the plug toward the socket. The operation of making a connection is extremely simple. When a subscriber's drop falls, the operator inserts an answering plug in the jack, restoring the shutter, and moves the handle of a combination listening and calling key or circuit-changer forward, which connects her with the calling subscriber. Having ascertained the number of the subscriber desired, the operator inserts the calling plug corresponding with the answering plug first used, in the desired subscriber's line jack and calls up that subscriber by pulling the handle of the circuit-changer backward. When the handle is restored to its normal position the two subscribers are connected and the exchange operator is cut out. The whole operation, therefore, consists of four motions on the part of the operator; two insertions of jacks and two motions of the combined listening and calling key or circuit-changer. The lever of the circuit-changer returns to its normal position automatically when released. All of the springs in the talking circuits are platinum-plated and rest on platinum-pointed contacts. The plugs are of the metallic-circuit type. It is claimed that these switchboards are absolutely free from any cross-talk.

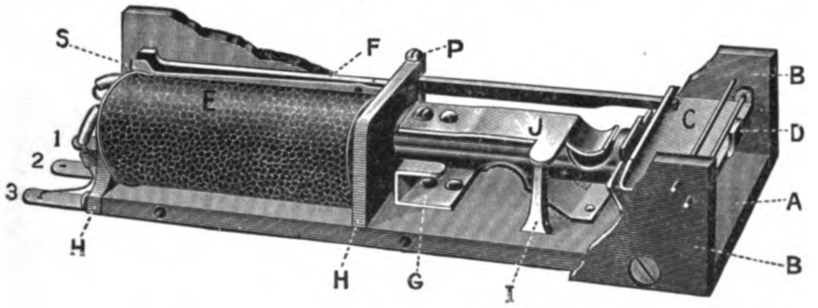


FIG. 13.—SPRING JACK AND PLUG-RESTORING DROP.

A NEW LONG-DISTANCE TELEPHONE OUTFIT.

Fig. 15 represents the latest type of magneto telephone outfit manufactured by the Stoddard Telephone Construction Company, Monroe, Mich., and known as Set No. 85. This outfit is made for both series and bridging circuits, and is said to be radically different from old models. The transmitter is of the solid-back type, and the transmitter cord is concealed in the arm; the receiver is the regular Stoddard bipolar instrument with the permanent magnet fastened at its pole ends. The induction coil is extra long and wound with silk-covered wire, of course. The receiver hook is of the long lever type, as shown in Fig. 15, with the contact springs mounted vertically, and with a Bell-style receiver fork. The magneto is unusually powerful and supplied with noiseless gearing; the armature is wound with silk-covered wire and equipped with an automatic cut-out.

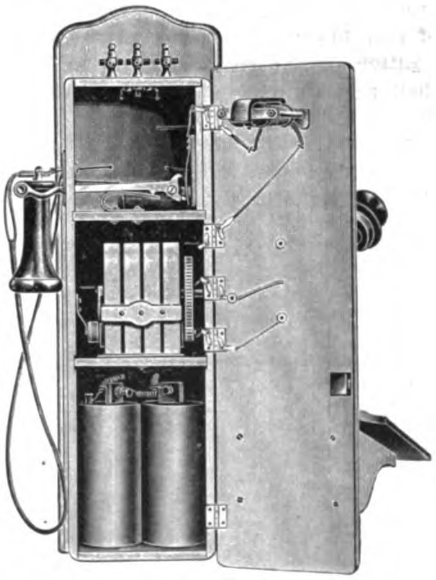


FIG. 15.—STODDARD TELEPHONE OUTFIT.

NEW TELEPHONE MAGNETOS.

Figs. 16 and 19, shown herewith, illustrate the two latest types of magetos built by the Connecticut Telephone & Electric Company, Meriden, Conn. The magnetos are similar as to general construction, the chief difference being in the size. The magnets are made from the best grade of magnet steel obtainable, carefully tempered and bent to such a form that they spring on to the pole-pieces and grip them tightly, the pole-pieces being held apart, of course, by a non-magnetic distance piece. Screws are used, however, as an additional precaution to secure the pole-pieces to the magnets, and ridges are provided on the back of each pole-piece which fit in the spaces between the magnet bars and prevent any tendency to lateral shifting. The armature core is laminated, carefully insulated, and compressed on a drawn steel shaft. The bearings are made extra long and of a close fit. The gears are extra heavy, made of a special grade of cast brass and are turned and cut in position on the shaft in order to insure their running absolutely true. The pole-pieces, which are made of the best grade of iron obtainable, are carefully bored out and fitted as close to the armature as mechanical conditions will allow, thus giving a minimum air gap. These magnetos are made for all of the usual arrangements of telephone circuits, and are mounted either on blocks or in cases with ringers and switch hooks. They are provided with either a series automatic shunt device or a bridging automatic cut-in arrangement. The latter is new, and consists of a small drum mounted on the end of the armature shaft and contains metal filings. These filings when the armature is in repose are in contact with only one terminal, but when it is rotated they are thrown outward by centrifugal force and complete the circuit between the armature and the line. The company also manufactures a double eight-magnet generator for use on lines where extra heavy output is desired.

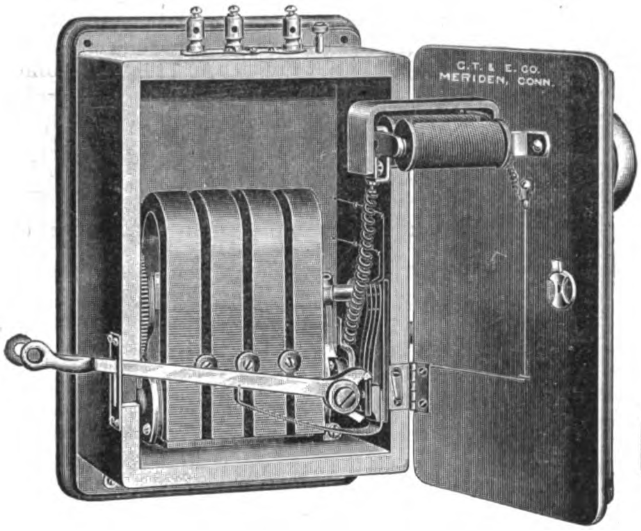


FIG. 16.—CONNECTICUT MAGNETO.

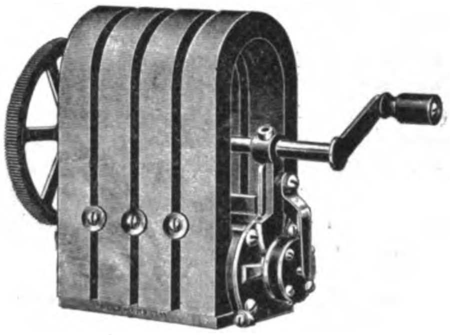


FIG. 19 —CONNECTICUT MAGNETO.

A SINGLE-POLE TELEPHONE LIGHTNING ARRESTER AND FUSE BLOCK.

Fig. 20 represents a single-pole type of combined telephone lightning arrester and fuse-block which is being marketed by the American Electric Fuse Company, Chicago. The construction will be familiar to those who are in touch with telephone work. The two vertical carbon blocks at the left-hand end of the device are separated by a sheet of dielectric material and form the lightning arrester, while the fuse is the familiar fuse link which has been in use for several years.

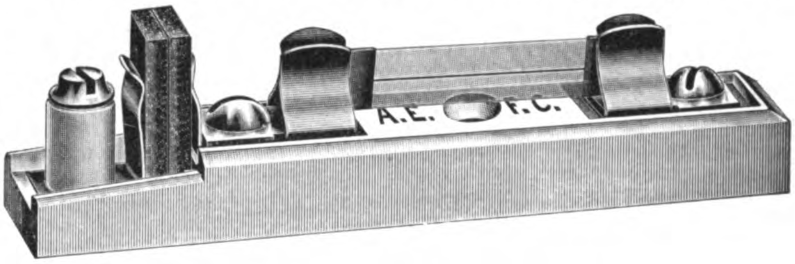
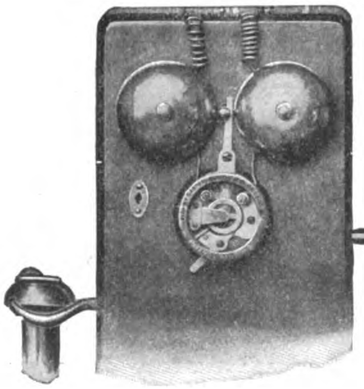


FIG. 20.—LIGHTNING ARRESTER AND FUSE BLOCK.

NEW EXTENSION CIRCUIT SIGNALLING APPARATUS.

A telephone extension signalling device, without magnet coils of any description, that does not insert any extra resistance in the circuit, and that resets itself after every signal, has been considered an ideal arrangement, but has not, we are informed, hitherto been offered on the market. The Garton-Daniels Company, of Keokuk, Iowa, maker of the well-known Garton Lightning Arresters, has recently brought out such an extension circuit ringer, illustrated by Figs. 17 and 18. Fig. 17 shows the ringer attached to the front of a magneto box, and Fig. 18 gives a larger view of it, detached. It will be noted that a lever, extending upward, is held against the bell-clapper of the magneto. When the bell-clapper vibrates, the extension circuit is closed, reproducing the signal wherever the bell is located. As soon as the bell-clapper of the magneto comes to rest, the circuit is again opened automatically.

In other forms of extension circuit-closing devices, a coil is depended upon to release a shutter, which closes the circuit when it falls. It is necessary to reset this shutter at once, or the battery will soon become exhausted. It frequently happens that calls come in when no one is around, and, again, lightning will sometimes throw the shutter at night when no one is present; in either case, the relay is not reset and the battery becomes exhausted. This trouble is obviated altogether by the ringer here described, as it resets itself after each signal. This device may also be used on party lines, where an ordinary drop would be of no value. The fact that the G.-D. ringer puts no resistance in the circuit will appeal to practical telephone men.



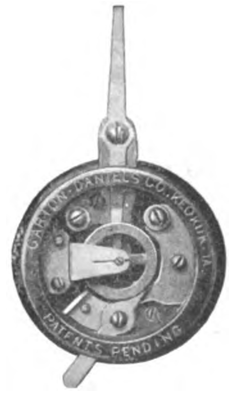
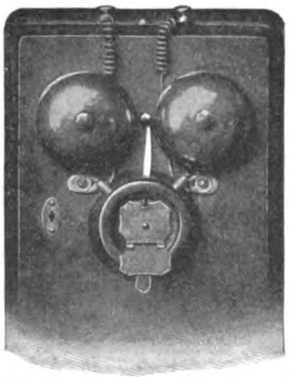


FIG. 17.—EXTENSION CIRCUIT RINGER—FIG. 18.



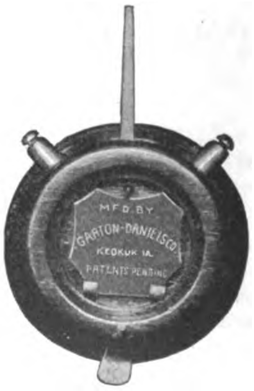


FIG. 21.—EXTENSION CIRCUIT CLOSER.—FIG. 22.

Fig. 22 shows an ordinary drop shutter circuit-closing relay now being placed on the market by the same company. This differs from other forms in that it is not dependent on the action of a magnet but is entirely mechanical, like the extension ringer just described. It is actuated by the motion of the bell-clapper of the magneto, the same as the extension ringer, but differs from the latter in that it must be reset after each signal. It is offered to meet the views of those who prefer the old form of circuit-closing drop. Fig. 21 shows the G.-D. circuit-closing drop in position on a magneto box.

A NEW FORM OF WALL TELEPHONE SET.

The Central Telephone & Electric Company, St. Louis, Mo., has just brought out the new form of wall set illustrated by Fig. 24. The feature of this set is the unusual arrangement of the instruments, which is said to be much more convenient than that of the more conventional style. Instead of mounting the transmitter on the magnetic box, the latter is brought down and combined with the battery box, the transmitter and induction coil being mounted alone on the upper part of the back board. This arrangement is evidently more convenient physically, as it is not necessary for one to reach upward in order to call up the central office or to remove the receiver from its hook. The set is handsomely finished, and the instruments are of the Central Company's standard long-distance types.

NEW GASOLINE RUNABOUT.

The Olds Motor Works, of Detroit, has introduced a new model of gasoline runabout illustrated by Fig. 23, which it has called the "Oldsmobile." The body is mounted, independent of motor and running gear, on rubber cushions about two feet from the ground. An Olds 4-h.p. gasoline motor furnishes the motive power, which is transmitted to the wheels by a roller chain, and is sufficient to drive the vehicle at speeds ranging from 10 to 25 miles an hour on a 22 degree gradient. The axle is provided with a differential gear, of course, as a single motor is used. The tank will hold sufficient gasoline for a 150-mile run, which has been found to require about 4 gallons. The runabout weighs less than 600 pounds, and is capable of sustaining over three times its own weight. It is furnished with heavy pneumatic rubber tires and a powerful brake.

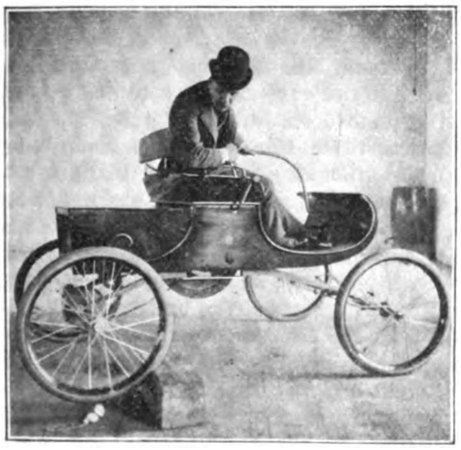


FIG. 23.—GASOLINE RUNABOUT.

MIANUS TELEPHONE OUTFIT.

Fig. 25 represents the standard telephone equipment of the Mianus Electric Company, Mianus, Conn. The set consists of a granular-carbon transmitter mounted on a Bell-type transmitter arm, a long induction coil, a Bell-type receiver and a 10,000-ohm magneto and bell. The battery box shown is extra size, for two cells of battery, but the set is furnished with any size of battery box desired up to three cells capacity. The transmitter is said to be a particularly loud talker, and to transmit articulation very clearly. The magneto is provided with a four-bar magnet arranged with two horse-shoes side by side and two others within the first two, thus securing the full advantage of compounding the magnets and at the same time making the machine unusually compact.

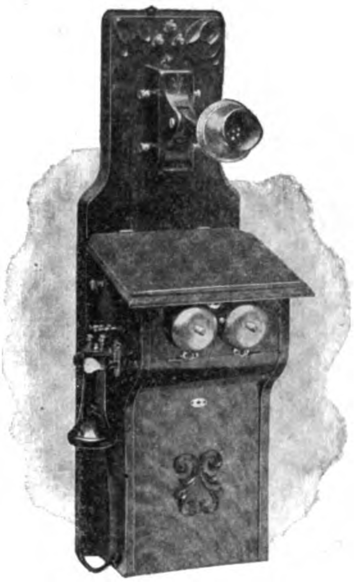


FIG. 24.—NEW WALL SET.

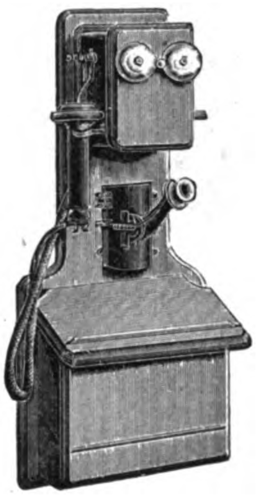


FIG. 25.

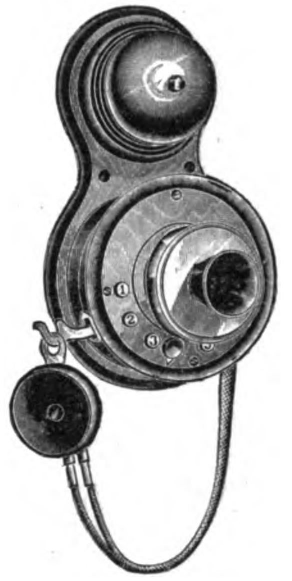


FIG. 26.

A COMPACT INTERCOMMUNICATING OUTFIT

The Spencer Electrical Company, New York, has just brought out the extremely compact and efficient intercommunicating set illustrated by Fig. 26 herewith. The features which differentiate this set from those of other intercommunicating systems are the use of a single centrally-located induction coil and the mounting of the transmitter on the pivot of the selective switch lever. The engraving shows very clearly the method of mounting the transmitter and switch, and it will be evident that this method secures greater compactness than could otherwise be obtained. The transmitter embodies special construction; the diaphragm is compound, consisting of an aluminum disc and a thin tin plated disc between which is interposed a tissue sheet. The diaphragm is held in place by a non-conducting washer which is faced with cork so as to avoid a harsh contact, and at the same time secure the positive location of the diaphragm. On the rear side of the diaphragm is bolted the usual carbon disc which works with a piston motion within a casing of yielding material secured to the rear electrode. The back electrode is soldered permanently to its metal mounting and held in a substantial metal cup which forms the center of a bridge or yoke across the back of the transmitter.

The system is a central-battery system, of course, as there is only one induction coil for all of the stations. The selective switch is of the simplest possible type, consisting of a spring lever which normally stands away from the contact buttons. In operating it is only necessary to swing the lever around until it is opposite the desired button and press it inward against the button. This calls up the station whose individual line is connected to that button. There is no interrelation between the receiver hook switch and the selective switch; stations can be called whether the receiver is on the hook or not. All of the connections in the outfit are thoroughly soldered except the receiver cord terminals. The binding posts used to hold these, however, are of such design that they cannot work loose nor twist in their sockets. These outfits are made for systems containing any number of stations up to twenty.

SPECIAL BRIDGING TELEPHONE OUTFIT.

Fig. 27 illustrates the No. 9-A bridging telephone outfit of the Farr Telephone & Construction Supply Company, Chicago, Ill. The component parts of this outfit are a solid back transmitter, bipolar receiver, long induction coil, a special five-magnet generator and a 1600-ohm ringer. The transmitter contains the unique feature of an aluminum diaphragm, for which strong claims are made. A carbon button is fastened to the rear side of the diaphragm, and between this and the stationary carbon electrode are the usual granular carbon particles. The re-

ceiver is bipolar. The magnet is mounted at its pole ends on a block of non-magnetic material, a part of which is threaded to fit a female thread in the receiver shell. The poles are of the usual oblong type wound with No. 37 silk-covered magnet wire to a resistance of 125 ohms. These receivers, it is stated, give the best results on long lines heavily loaded with instruments. The magneto is unusually powerful, being capable of ringing through 50,000 ohms resistance. The armature core is laminated and carefully fitted to the pole-pieces. The ringer has

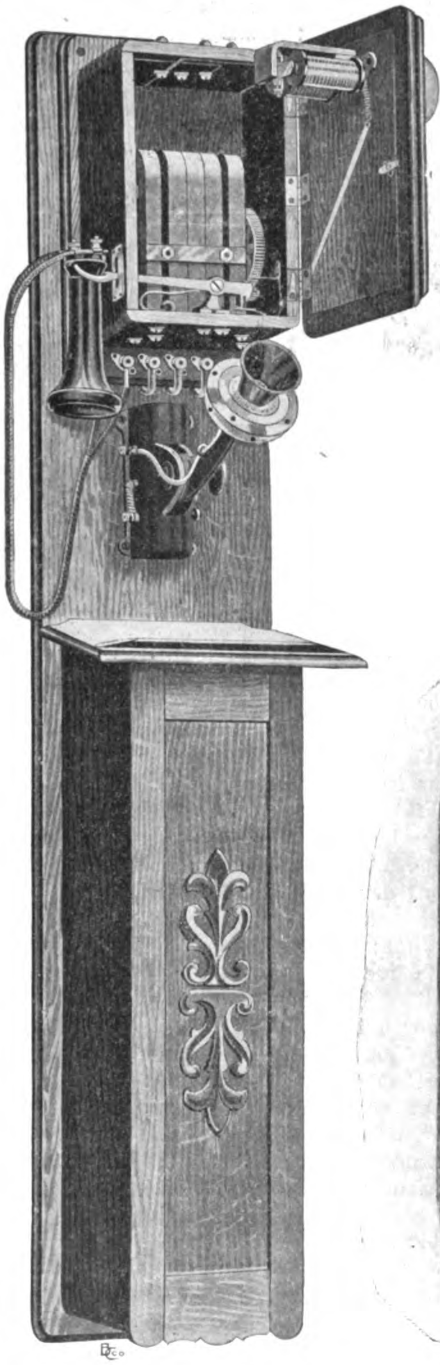


FIG. 27.—BRIDGING OUTFIT.

1600-ohm magnet coils. The set is built for bridging lines where 20 to 25 telephones are connected up on one circuit. The case is made of either oak or walnut with a high-grade piano finish.

KEELYN RECEIVER AND TRANSMITTER.

Fig. 28 illustrates a telephone receiver and transmitter equipment of very grace**ful design which is being marketed by the Keelyn Telephone Manufacturing Company, Chicago, Ill. The receiver is of the bipolar type, with the magnet supported at its poles, so as to obviate trouble from unequal expansion of the case and the magnet. A feature upon which the manufacturer lays particular stress is the high insulation of the receiver circuits and the arrangement of the flexible cord. There are no metallic parts exposed on the receiver, the connections of the cord being made within the case. The cord is held mechanically by a button, so as to** remove the strain from the conductors and the terminals inside the receiver shell. The transmitter is of the usual granular-carbon type, but its construction is unusual in that the back half of the case is cast in one piece with the transmitter arm. The parts of the transmitter consist simply of a diaphragm, a carbon block and carbon granules lying between the diaphragm and the block. The design is such that there is a deep recess around the circular carbon block, which is filled by granular carbon; this arrangement, it is claimed, adds to the efficiency of the transmitter by providing a larger **variable contact area. The base of the transmitter arm contains an induction coil, as usual.**

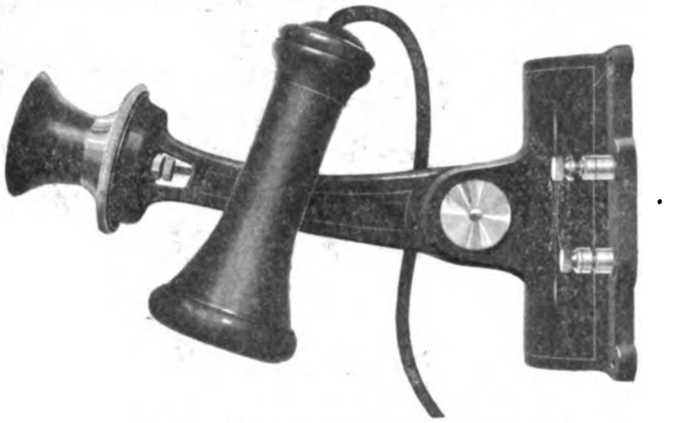


FIG. 28.—KEELYN RECEIVER AND TRANSMITTER.

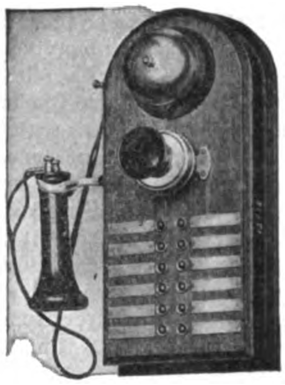


FIG. 30.

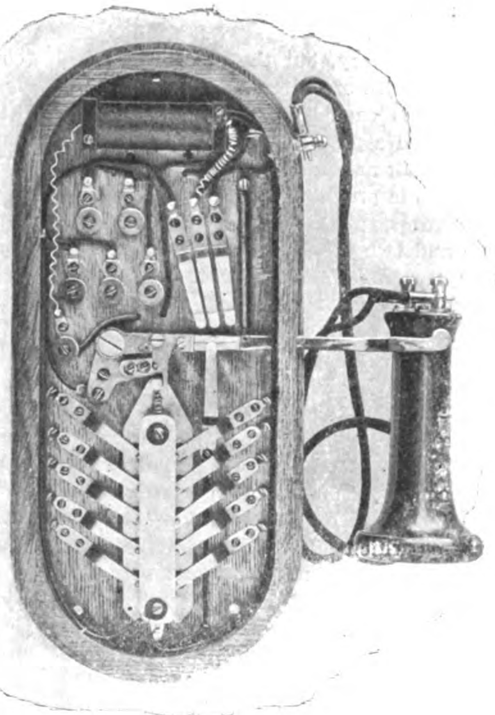


FIG. 29.—SWITCHLESS INTERCOMMUNICATING SYSTEM.

DE VEAU SWITCHLESS INTERCOMMUNICATING SYSTEM.

Stanley & Patterson, of New York City, are just bringing out an entirely new intercommunicating system, a feature of which is that no switches are employed, except the ordinary receiver hook switch. Fig. 30 shows the front of an intercommunicating set, and Fig. 29 is a rear view, showing the mechanism. The diagonal springs are the line springs connected to the individual lines of the various stations; the vertical strip in the foreground is the battery connection, and the plate just back of this strip and the line springs, the upper end of which is triangular, is the common-return connection. This common-return plate is arranged to move up and down on guides, and is perforated with a series of holes corresponding in number and position to the line springs and push-buttons. The plate is normally held in its upper position by a spring. There is a series of push-buttons mounted in the front of the box, as shown in Fig. 30. **These buttons have each a shank with** a tapered head exactly like the pointed head of an upset rivet. **Pressing one of the push buttons forces this tapered head through a hole in the common-return plate and the tapering edge impinges** against the edge of this hole and presses the plate downward until after the head passes through, when the plate is pulled up by its spring and keeps the push-button from springing back. The tapered head of the push-button shank engages the line spring opposite to it, and when the button is pushed to its extreme limit it forces this spring against the battery plate, calling up the desired subscriber. When the button is released it flies back but is caught half way by the movable common-return plate, as above described, and connects the line spring with this plate.

When the receiver is placed on the hook after the conversation is finished a pawl mounted on the hook lever engages a lug on the common-return plate and pushes the plate downward just far enough to release the push button, which thereupon springs outward into its normal position. Continuing in its downward movement, however, the pawl on the receiver hook lever is thrown out of engagement with the lug on the common-return plate, and this plate returns to its upper position. It is plain that conversation may be carried on with any number of stations simultaneously as it is only necessary to press the push buttons of the various stations in order to connect them all in multiple between their individual lines and the common-return line.

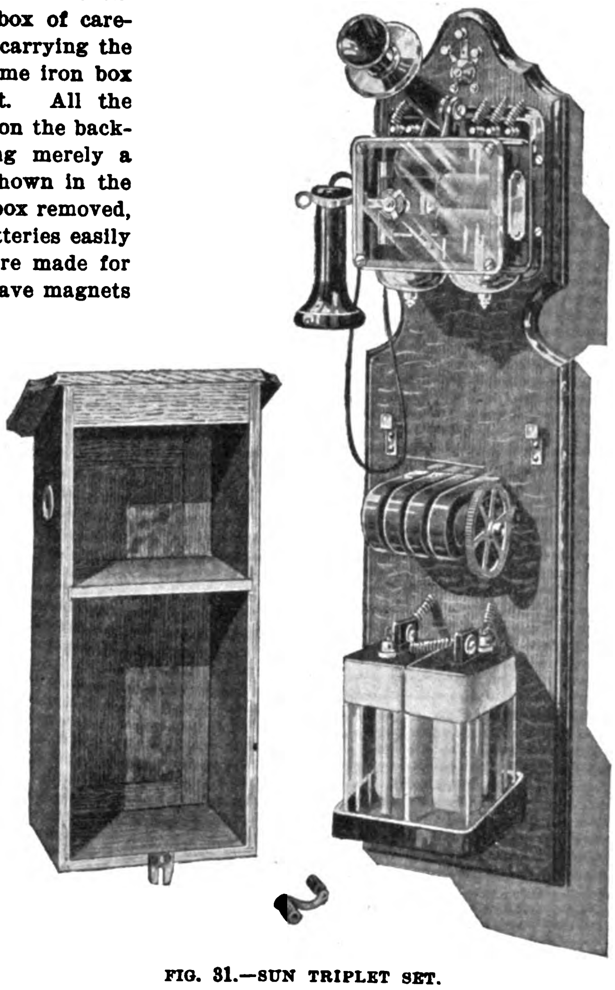


FIG. 31.—SUN TRIPLET SET.

A HANDSOME TELEPHONE OUTFIT.

Fig. 31 illustrates a very handsomely finished telephone equipment made by the Sun Electric Manufacturing Company, Philadelphia, and known as Wall Set Type A, No. 1. It has an ornamental backboard and panelled battery box of carefully selected quartered oak, carrying the Sun "triplet set" in a handsome iron box with heavy plate-glass front. All the parts are mounted directly upon the backboard, the battery box being merely a protective cover, as clearly shown in the engraving, which shows this box removed, making the generator and batteries easily accessible. The generators are made for series or bridged work, and have magnets of the highest quality of magnet steel purchasable. The armatures are laminated, of the best quality soft Swedish iron, carefully trued up, and turned so as to secure as small an air gap between the armature and the pole-pieces as it is possible to obtain.

In the transmitter the familiar piston movement is employed, the front electrode being solidly attached to the diaphragm and working in a chamber hollowed out of the solid metal which forms the rear half of the shell. The two halves of the shell are of cast brass, both being accurately turned so as to be true in their fit and perfect in their centering. The electrode chamber, being formed directly in the rear half of the shell and centered therein in the making of the shell, is true not only in its conformation but in regard to the other elements in the structure. This enables the company to make all parts interchangeable and the adjustment permanent. It is adjusted once for all at the factory, and then sealed up.

The receiver is new, like the transmitter. It has a genuine hard-rubber shell, and a cap that contains a series of small perforations instead of the single large opening usually used. The magnet structure is made as a unit, assembled and adjusted without regard to the shell. The magnet steel is specially made under a formula and guaranteed to preserve its magnetism at full strength. The cord is secured to the magnet structure, and there are no external binding posts. The entire magnet structure is carried on a metal disc adjustable in a metal ring which carries the diaphragm. The induction coil is 5 ins. in length by 1⅛ ins. in diameter, with hard-rubber ends; the primary and secondary windings are of silk-insulated magnet wire, brought out to terminals on the rubber ends and soldered. The resistance and talking qualities of these coils are the same as those used by the Bell company.

The hook switch is said to be different from that used by other manufacturers. It has a metal base made in one piece, with upturned ends to which the contact springs are secured solidly by screws and metal nuts. Insulation is secured by interposed non-conducting washers and bushings. The springs rest under tension on a central post, which has a rubber jacket for the purpose; the hook itself is secured on a sleeve which slips over a second post on the base. Around the sleeve is a coiled steel spring held in place by a spider, and the contact arm of the hook is also carried on the sleeve. The entire hook, spring and all, may be slipped off the base post and removed at will, for inspection, repairs, or testing, and as easily slipped back. All parts are standardized and interchangeable.

The lightning arrester is also of a new design and said to possess certain advantages not found in others. It has two line strips arranged in the general outline of a shield, with an intermediate strip for ground.

LEGAL NOTES.

IDE ENGINE PATENTS.—In an infringement suit of Addie F. Ide, et al., executors of the late A. L. Ide, vs. Trorlicht, Duncker & Renard Carpet Company, et al. and J. F. Chuse and Richard Heap, defendants, in the Circuit Court of the United States for the Eastern Division of Eastern Judicial District of Missouri, Judge Adams handed down a decision to the effect that the engines manufactured by the last-named defendants do not infringe the Ide patents.

TESLA SPLIT-PHASE MOTOR PATENTS.—The United States Circuit Court for the southern district of Ohio has rendered a decision in favor of the Westinghouse Company in two suits brought by that company against the Dayton Fan & Motor Company for infringement of the Tesla patents Nos. 401,520, 511,559 and 511,560. The first-named patent covers the method of operating single-phase motors by "splitting the phase," and the latter two patents cover means for accomplishing the necessary phase-splitting.

PERSONALS.

MR. E. T. PARDEE has joined the staff of the Bullock Electric Manufacturing Company at its New England office in Boston.

MR. C. E. COLLINGS, a well-known electrical engineer, formerly of Mobile, Ala., has joined forces with the Century Electric Wiring Company, Turtle Creek, Pa.

MR. W. F. GREENWOOD, general manager and chief engineer of the Havana Electric Company, Havana, Cuba, was recently in New York City on a short business trip.

MR. R. H. KLAUDER, formerly of the Philadelphia staff of the Electric Storage Battery Company, has been appointed manager of the company's new branch office at St. Louis, Mo.

MR. C. C. WARREN, president of the Warren Electric Manufacturing Company, Sandusky, Ohio, sailed from New York with his wife on the steamship Trinidad for Bermuda, on February 16.

MR. STEWART S. NEFF has been appointed superintendent for the Boston Elevated Railway Company. Mr. Neff is a well-known railroad man and amply qualified for his new position.

MR. A. J. BAGNALL, of the well-known firm of Bagnall & Hilles, of Yokohama, Singapore and Manila, is on a visit to the United States for the purpose of purchasing supplies for a projected electric railway in Tokyo, Japan.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, has put on the market a new hotel telephone system which is said to have many points of advantage over the ordinary intercommunicating systems previously marketed.

MR. PAUL BIGELOW, formerly electrician in charge of the Department of Yards and Docks at the New York Navy Yard, has resigned his position to accept the representation of the Buckeye Engine Company, of Salem, Ohio, in this city.

MR. GEORGE P. LOW, editor of the "Journal of Electricity, Power and Gas," has been appointed local honorary secretary at San Francisco by the American Institute of Electrical Engineers, to succeed Dr. F. A. C. Perrine, who recently resigned this office.

MR. E. F. SEIXAS has resigned his position as general manager of the Amsterdam (N. Y.) Street Railway to take a similar position with the Niagara, St. Catherines & Toronto Railway, and the Niagara Falls, Wesley Park & Clifton Tramway Company.

MR. J. W. PETERSON, of Chicago, has joined the Chicago staff of the Northern Electrical Manufacturing Company and the Stanley Electrical Manufacturing Company, and will hereafter concentrate his well-known ability upon the sale of Northern and Stanley apparatus.

MR. EDWIN BURHORNE has engaged in general engineering and contract work with offices at 62 Wall Street, New York. Mr. Burhorne has made a specialty of designing and erecting steam and electric plants, and states that he is glad to handle cases involving unusual difficulties.

MR. F. A. WUNDER, who for several years represented the Fort Wayne Electric Works and the Siemens & Halske Electric Company of America in New York City, has been appointed general sales agent for the Ball Electric Company, with headquarters at 95 Liberty Street, New York.

MR. W. S. BROWN, formerly with the Sprague Electric Company, has severed his connection with that company to take the management of the Eastern sales department of the Richmondt Electric Wire Conduit Company. Mr. Brown's headquarters will be at 39 Cortlandt Street, New York.

MR. JOHN B. BENNETT, for several years business manager of the "Street Railway Journal," has resigned his position on that paper and acquired an interest in the "Municipal Journal and Engineer," of which he will be the business manager. The American Electrician joins with Mr. Bennett's many friends in wishing him the full measure of success which his high ability merits.

MR. LEVI TEAL, of the S. S. White Dental Manufacturing Company, Philadelphia, Pa., was quietly married on Tuesday, February 26, to Miss Annie E. Haas, of Philadelphia. Mr. and Mrs. Teal will spend their honeymoon in the South, and upon returning to Philadelphia will reside at 2109 N. Twelfth Street. The American Electrician joins with their many friends in wishing them a happy and prosperous future.

MR. THEO. G. SEIXAS was married on February 14 to Miss Amelie L. Bunout, at the home of the bride's mother, in New York City. Mr. Seixas is vice-president and superintendent of the Germantown Electric Light Company, Philadelphia, and was for several years associated with Mr. Edison at his laboratory. The American Electrician joins the numerous friends of the young couple in wishing them a happy and prosperous life. Mr. and Mrs. Seixas will reside in Philadelphia.

MR. A. WILFORD ZAHM has resigned his position of secretary and general manager of the Manhattan Light, Heat & Power Company, of St. Paul, Minn., to accept a similar position with the Light, Heat, Transit & Public Service Company, of St. Cloud, Minn. This company is a consolidation of the Benton Power & Traction Company and the Hertig Light & Heat Company, and operates the St. Cloud and Sauk Rapids Street Railway and an electric-lighting and steam-heating plant for furnishing light and heat in St. Cloud and Sauk Rapids.

TRADE PUBLICATIONS.

CALENDARS.—The Cutter Company, Philadelphia.—Two attractive calendars consisting of red cardboard sheets bearing the usual calendar blocks divided into monthly leaves, and also showing pictures of I. T. E. circuit-breakers.

BLOW-OFF VALVES AND SWING JOINTS. The Bordo Valve Company, Philadelphia.—A pamphlet catalogue, vest-pocket size, containing illustrations, descriptions and price lists of the Bordo plug valves and swing pipe-joints.

KNIFE-BLADE SWITCHES. H. P. White Company, Ltd., Philadelphia.—A pocket-size pamphlet catalogue of White knife-blade switches which are made in all of the usual combinations. The peculiar feature of these switches is an inturned flexible jaw.

LIST OF PRODUCTS. American Steel & Wire Company, Chicago.—A pamphlet of small pocket size containing an enumeration of all of the products of the American Steel & Wire Company. This is not in any sense a price list, but merely a list of the articles manufactured.

MEMORANDUM BOOK. Hugo Reisinger, New York.—A neat little vest-pocket memorandum book with a leather cover and removable pad of leaves. The leaves are lined in cross-section with blue ink, and an auxiliary pad accompanies the cover and the pad already within it.

CALENDAR. The D. M. Steward Manufacturing Company, Chattanooga, Tenn.—A hanging calendar carrying a monthly-leaf pad of large size, and bearing an allegorical picture in colors which represents Uncle Sam using the Steward 4-H lava burner as a cannon to demolish British fortifications.

CALENDAR. D. L. Bates & Bro., Dayton, Ohio.—A hanging calendar comprising a stout pasteboard backing, on which are mounted a handsome photograph of two dogs and a small monthly-leaf calendar pad. The photograph includes also a picture of a Dayton fan motor, and is captioned "Prize Winners."

HEATING AND VENTILATING THE LARGEST ROUND HOUSE IN THE WORLD. B. F. Sturtevant Company, Boston, Mass.—An ornamental double-fold pamphlet containing a brief description of the Sturtevant heating and ventilating plant in a round house on the Chicago & Northwestern Railroad.

STEAM TURBINES. The Westinghouse Machine Company.—This is a handsomely-executed reprint of the paper read by Mr. Francis Hodgkinson last November before the Engineers' Society of Western Pennsylvania. The paper is extremely interesting and contains a considerable amount of useful information.

DIARY AND CATALOGUE OF SMALL TOOLS. Smith & Hemenway Company, New York.—This is a diary, or rather a dated memorandum book, for the current year. Each page is divided into seven spaces, so that a page covers exactly a week. The small tools illustrated in the book are plyers, glass cutters, snips, shears, etc.

SERIES-PARALLEL SYSTEM OF MOTOR CONTROL.—The C & C Electric Company, New York.—This is Bulletin No. 138, containing a resume of methods employed in the operation of newspaper presses, and a detailed description of the company's new system of motor control for such presses, which was described in our January number. The book is of the standard catalogue size and well illustrated.

DIRECT-CURRENT MOTORS. The Emerson Electric Manufacturing Company, St. Louis, Mo.—This is Bulletin No. 3,028, containing illustrations, a description and price list of a new line of direct-current motors which the Emerson Company has just brought out. The motors are made in three sizes, ¼, ½ and 1/3 horse-power, and are supplied wound for slow speed, medium speed or high speed, and for either 110 or 220 volts.

ELECTRICAL APPARATUS AND SUPPLIES.—Varney Electrical Supply Company, Indianapolis, Ind.—This is a general catalogue of dynamos, motors, telephones, telephone apparatus, arc lamps, and electric light and railway supplies. Its distinctive feature, however, lies in the arrangement of the leaves, which are removable and may be therefore changed from time to time as prices and types of appliances change. This characteristic has led the Varney Company to designate it a "perpetual catalogue."

COMPARATIVE INCANDESCENT LAMP TESTS. Western Electric Company.—This is a most elaborate and handsomely-executed book, containing diagrams of tests made with incandescent lamps of various makes, the object being to obtain a comparison between the Sunbeam and other lamps. The tests are plotted on charts 10 x 12 ins., and to a correspondingly large scale, but they do not seem to have been accurately taken, as the candle-hour curves show several "saw teeth" beyond the initial rise and fall which is always obtained.

CALENDAR. The Electric Motor & Equipment Company, Newark, N. J.—This is the most ornamental advertising calendar that has come to light so far this year. It comprises a celluloid face plate of ornamental shape and bearing tasteful pictures of flowers and birds executed accurately in natural colors; together with a revolving dial pivoted back of the face plate. The dial bears the days of the week and the names of the months, which show through slots in the

A COMMUTATOR NECESSITY.

For Sale by all Supply Houses.

Upon receipt of this coupon we will send FREE, sample stick.

Name..

Address..

A. E.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.
50c. per Stick. $5.00 per Dozen.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO.

face plate. The latter bears the days of the month and the years. The calendar is good up to 1909, and is worthy of a place on any desk.

BUSINESS NEWS.

THE GORDON BATTERY COMPANY, New York, has moved its place of business to 13 and 15 Laight Street.

THE HUDSON PORCELAIN WORKS, New York, is now manufacturing a full line of insulators, cleats, etc., for telephone, telegraph and electric-light construction.

THE PELTON ENGINEERING COMPANY, Cleveland, Ohio, has removed its office and factory to No. 16 Merwin Street, where it has larger facilities than heretofore.

MR. ROBERT HUTCHIN JEFFREY, of Columbus, Ohio, general manager of the Jeffrey Manufacturing Company, was married on February 6 to Miss Alice Kilbourne, of Columbus.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa., have removed their New York office to larger and more suitable quarters at No. 7 West Twenty-second Street.

THE EASTERN ELECTRIC COMPANY, Middleton, Mass., has moved its business to Lynn, Mass. The company manufactures incandescent lamps and expects to double its output in the Lynn plant.

GEORGE W. HOFFMAN, Indianapolis, Ind., reports a brisk trade in his U. S. metal polish. Among other orders recently received was one for five barrels and ten cases to be forwarded immediately.

THE NORTH ELECTRIC COMPANY, of Cleveland, Ohio, has opened an office for its telephone trade in the West, at 1511 Monadnock Block, Chicago, which is under the management of Mr. George W. Conover.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, recently received an order from the Havana Street Railway Company, Havana, Cuba, for two 150-gallon Cross oil filters for the new Havana power house.

BAKER & CO., Newark, N. J., dealers in platinum, state that this metal has never been so high as at the present time. Indications, as a result of this condition, point to an early and considerable increase over present quotations for platinum.

THE PITTSBURG BOILER SCALE RESOLVENT COMPANY, Pittsburg, Pa., has received an order from the United States Government for a quantity of boiler scale resolvent to be used in the boilers of the government ice plant at Iloilo, Philippine Islands.

THE VARLEY DUPLEX MAGNET COMPANY has removed its factory from Jersey City, N. J. to Phillipsdale, R. I. This change in location will enable the company to avoid all delays incident to the transportation of raw material, as it will obtain wire from the American Electrical Works located at the same place.

I. P. FRINK, New York, has just completed a notable installation of lighting fixtures in one of the New York City churches The illumination is secured almost entirely by concealed lamps backed by powerful Frink reflectors which throw the light upon a large domed ceiling, the ceiling serving to again reflect and diffuse the light.

H. M. SHAW & CO., New York, manufacturers of Shaw's non-arcing lightning arrester, have secured the exclusive management and control of the Medbury insulation, so well and favorably known to the street railway trade, and is in position to supply promptly all the designs of overhead material at prices consistent with high grade workmanship.

WARD LEONARD ELECTRIC COMPANY, Bronxville, N. Y., calls attention to the importance of patent No. 668,140, which was issued to Mr. H. B. Cutter on February 12 and is owned by Mr. H. Ward Leonard. This patent covers the use of an automatic circuit-breaker in series with an automatic motor-starter, which combination is now almost universally used.

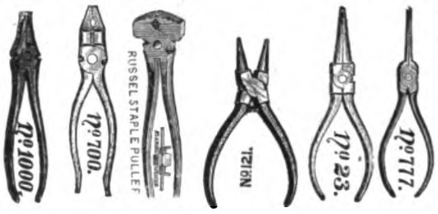
H. J. LINDER & COMPANY.—The copartnership doing business under the firm name of H. J. Linder & Company, at 128 Liberty Street, New York, was, on January 31, dissolved by mutual consent. The firm consisted of James W. Sturges and Herbert J. Linder. Mr. Sturges will continue the business of supplying complete power and electrical appliances under his own name and at the old address.

McKENNA BROTHERS BRASS COMPANY, Pittsburg, Pa., has had plans made for an eight-story factory building to cost about $100,000, the work on which is to begin not later than April 1. The new building will occupy a ground area of 84 x 100 ft., and will be provided with the most modern machinery, much of which will be specially designed for the manufacture of the brass specialties constituting the company's line.

BALL ENGINE COMPANY, Erie, Pa., reports the following recent export shipments of Ball engines: One 40-h.p. simple engine and one 75-h.p. compound direct-connected engine to Japan; two 125-h.p. tandem compound engines to Russia; one 50-h.p. simple engine to Honolulu; one 60-h.p. direct-connected engine to Vera Cruz, Mexico; one 150-h.p. cross compound engine to British Columbia, and one 400-h.p. direct-connected engine to England.

Telephone Service
Puts the Whole Organization of a Great City at Your Fingers' Ends Day and Night and in All Weathers.
Rates in Manhattan from $5.00 a Month.
One year contracts. Monthly payments.
NEW YORK TELEPHONE CO.
111 West 38th St. 15 Dey Street.

BIG STICK, 35 CENTS.
Sample Free.
SOUTHWORTH & HARE,
Indianapolis, Ind.


No 1000.
No 700.
RUSSEL STAPLE PULLER
No 121
No 23.
No 777.

NIPPERS and PLYERS
bearing our name are unexcelled.
Try them and be convinced.
Utica Drop Forge & Tool Co.,
SMITH & HEMENWAY CO.,
296 Broadway, New York.

GENUINE ERICSSON SWEDISH COAL-GRAIN
MICROPHONE
THE PERFECT TRANSMITTER.
NO PACKING, NO ADJUSTING, NO TROUBLE. ALSO COMPLETE LINE LONG DISTANCE TELEPHONES.
ERICSSON TELEPHONE CO. 296 BROADWAY N.Y

CREAM FLUX

An Absolutely Non-Corrosive Insulating Soldering Flux FOR ALL METALS. Contains no Acid or any Element Injurious to Electrical Connections. **We guarantee it, and if not satisfactory, Money will be Refunded.** You can make more than double the number of perfect connections in one half the time with CREAM FLUX than you can with the same amount of any other flux.

PUT UP IN CANS AT 15c, 25c, 45c, and 75c. SEND FOR TRIAL BOX. SPECIAL PRICES IN QUANTITY.

THIS IS WHAT ONE USER HAS TO SAY: "After having tried the various soldering salts on the market, and after giving your **CREAM FLUX** severe tests on heavy cable connections, and on the finest stranded flexible drop cord work, we can safely say it meets all claims you make for it. I consider it one of the best ever offered for sale. Yours truly,
CHICAGO EDISON CO.,
Per J. H. Goehst, Constr. Supt."

Endorsed by the National Board of Fire Underwriters and all users. For sale by all supply houses or

CREAM FLUX CO., Sole Manufacturers, 909-100 Washington St., CHICAGO

PLATINUM
In Sheet or Wire, any Degree of Hardness.
FOR ALL PURPOSES.
BAKER & CO.,
NEWARK, N. J.
New York Office, 120 Liberty Street,

JAS. LEFFEL & CO., Springfield, Ohio, have in progress an addition to their factory covering a ground space 90 x 220 feet. The new part of the factory will be built of brick and steel, and fully equipped with new machinery for the manufacture of the well-known Samson water wheel. The company has just received an order for a 3000-h.p. pair of horizontal wheels from Minneapolis, and a contract from Michigan for ten 68-in. Samson wheels to drive electric generators.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, has sold for installation in the steamer "Exporter," running between St. Louis and New Orleans, a complete electric plant consisting of a vertical engine with direct-connected generator. The same company has sold through Thebaud Brothers, exporters, several machines to go to Merida, Mexico, one to Mexico City, and one for British Honduras. The consignment to Mexico and British Honduras is intended for lighting service.

RICHMONDT ELECTRIC WIRE CONDUIT COMPANY, Milwaukee, Wis., recently filed articles of incorporation with a capitalization of $50,000. The incorporators are Daniel E. Murphy, C. D. Richmondt and D. Hayes Murphy. This company manufactures a unique type of interior iron conduit, the feature of which is that the inner wall is smoothly enameled throughout. The company will shortly occupy a new building 85 x 400 ft. and will then have ample facilities for taking care of its rapidly growing business.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, has added to its well-known line of direct-current machinery a full line of alternating-current generators, motors, rotary converters and transformers for all standard voltages and phases. The designs are those which have been made well known through Europe by the Oerlikon Company, of Switzerland. The Bullock Company has recently opened an office at 675 Ellicott Square, Buffalo, which will be under the management of Francis B. Smith, an electrical engineer of wide practical experience.

WALKER ELECTRICAL CONSTRUCTION COMPANY, Philadelphia, under which style Mr. F. Dinwiddie Walker has heretofore traded, has been succeeded by a new limited co-partnership with the name and style of Walker Electric Company, Registered. Mr. H. H. Walker will liquidate the affairs of the old concern. The new firm will carry on the manufacture and sale of switchboards and other electrical appliances at the corner of Eighteenth and Hamilton Streets, Philadelphia. The members of the company are Henry H. Walker, F. Dinwiddie Walker, Bennett L. Johnson and Hervey S. Walker.

MONTAUK MULTIPHASE CABLE.—Montauk Multiphase Cable Company, New York, has made repeated applications to the Board of Fire Underwriters for recognition, but this has heretofore been withheld for the reason that the individual members of the Board, while conceding the merits of the cable, were unwilling to indorse a patented device by name. At a meeting of the Board held Feb. 22 the Committee on Patents submitted a report recommending the approval of a fire-detecting wire as a valuable adjunct, and the Board adopted the Committee's report without a dissenting voice. While no name was mentioned, it is understood that the wire was that of the Montauk Multiphase Cable Company.

THE GILLILAND ELECTRIC COMPANY, Adrian, Michigan, has resumed on a large scale the manufacture of telephone and electrical specialties. The Gilliland Company, which was organized in 1887, for many years manufactured all the pins and brackets for the largest telephone and telegraph companies in the United States. Mr. James F. Gilliland, the manager of the company, is an experienced telephone man, and has invented and patented large numbers of electrical and telephonic devices. The company has installed complete wood and metal working machinery and is prepared to furnish all forms of cabinet work, pins and brackets and is also equipped to manufacture many specialties. Its well-equipped plant with capacity for 1,000 men enables it to fill all orders with promptness, and its favorable situation gives it exceptional advantages with regard to the cost of manufacture.

THE LARGEST SINGLE ORDER FOR TRANSFORMERS EVER RECORDED.—The Westinghouse Electric & Manufacturing Company recently received from the Chambly Manufacturing Company an order for twenty 2750-kw. transformers of the Westinghouse air-blast type. Each of these, with an output of over 3600 horse-power of electrical energy, weighs approximately 11 tons and stands 9 ft. high. Of the twenty units, ten are to be used to raise the voltage from 2200 to 25,000 volts at 66 2/3 cycles. The input is two-phase and the output three-phase. The remaining ten transformers, for lowering the voltage, receive the three-phase line currents at 22,000 volts and deliver two-phase currents at 2400 or 4800 volts as required. The well-known Westinghouse methods of construction are employed in these transformers, both primary and secondary being divided into several flat coils wound with many layers, and few turns per layer, each coil being insulated separately. Iron and copper have been carefully proportioned to secure the minimum losses, and the efficiency of the transformers is very high, being considerably over 98 per cent. The iron is specially treated to minimize the increase in iron losses from "ageing." We are informed that this is the largest order for transformers that has ever been placed.

A. L. IDE & SONS, Springfield, Ill., report among other recent orders the following sales of engines for lighting and power service: Great Northern Railway, one 125-h.p., direct-connected; Bemis Brothers Bag Company, one 80-h.p., direct-connected; Northwestern Fixture Company, one 300-h.p., belted; Village of Ada, one 125-h.p., direct-connected; Nixon & Snell, one 125-h.p., belted; B. S. Sivley, one 125-h.p., belted; S. E. Olson Company, one 200-h.p., direct-connected; Illinois Central Railroad, two 470-h.p., and one 160-h.p., direct-connected; Urbana Light, Heat & Power Company, one 175-h.p., and one 100-h.p., direct-connected; City of Hastings, two 150-h.p., direct-connected; Pennsylvania Lines, one 80-h.p., direct-connected, and one 80-h.p., belted; City of Bellevue, one 100-h.p., belted; State Capitol, two 125-h.p., direct-connected; Central Investment Company, one 50-h.p., and one 125-h.p., direct-connected; Cass Land Company, one 100-h.p., direct-connected; Electric Light Company, one 125-h.p., belted; Otis Elevator Company, one 160-h.p., and one 250-h.p., direct-connected; Illinois State Reformatory, one 175-h.p., belted; American Smelting & Refining Company, one 60-h.p., belted; Iowa State University, one 150-h.p., direct-connected; Imgri. Giorgi, one 50-h.p., belted; Daniel Adamson & Co., one 80-h.p., belted, and one 150-h.p., direct-connected; Soldiers' Home, one 100-h.p., direct-connected; Crane Company, one 100-h.p., direct-connected; Lincoln Trust Building, one 150-h.p., direct-connected; Hospital for Insane, two 125-h.p., direct-connected; City Gas & Electric Company, one 250-h.p., belted; James Mitchell & Co., one 50-h.p., belted; Marshall-Wells Hardware Company, one 125-h.p., and one 160-h.p., direct-connected; City of Iola, one 80-h.p., belted; Stiefel Building, one 125-h.p., direct-connected; Village of Blue Island, one 175-h.p., belted; City of Coffeyville, two 100-h.p., belted; Northern Pacific Railroad, one 175-h.p., belted; Lake City Electric Company, one 150-h.p., direct-connected; State Reform School, one 100-h.p., direct-connected; Seattle Lumber Company, one 110-h.p., belted; Lincoln Gas & Electric Company, one 250-h.p., direct-connected; Dwight Furness Company, one 100-h.p., belted; American Car & Foundry Company, two 175-h.p., direct-connected; Thompson-Taylor Spice Company, one 100-h.p., direct-connected; School for the Deaf, one 100-h.p., direct-connected; Union Restaurant, one 125-h.p., direct-connected; Klausman Brewery, one 125-h.p., direct-connected.

SOLID TRAINS TO NORTHERN MICHIGAN.

The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

A TRACY
OIL FILTER
costs a little more but it is sure to be the cheapest in the end: and it is SURE to clean your waste oil. Let us send you one on approval to be returned at our expense if it cannot do the work. Send for Circular.
Phœnix
Automatic Filter Co.,
Racine, Wis., U. S. A.

THE MASON GOVERNOR
For ELEVATOR PUMPS.
The important feature with this governor is that it operates on the slightest change of pressure, opening and closing the steam valve to its full extent promptly and with a certainty.
The Mason By-Pass or Water Relief Valve.
In many cases it is desirable to use a power pump for elevator or other service, driven from a line shaft or motor which has other work to perform, and cannot be constantly stopping and starting, but must run continuously. It is for this purpose that our by-pass valve is used.
CATALOGUE MAILED UPON APPLICATION.
THE MASON REGULATOR CO.,
6 Oliver Street, - BOSTON, MASS.

American Electrician.

Vol. XIII. New York, April, 1901. No. 4.

ALTERNATING CURRENT POWER EQUIPMENT IN A PACKING HOUSE.

CENTRALIZED POWER PLANTS OF SWIFT & COMPANY, AT CHICAGO AND ST. JOSEPH.

The introduction of electric transmission has made possible a revolution in methods of operation in packing houses. In all the largest packing plants of the west the numerous small steam plants of former days are being eliminated as far as possible and power is being generated in one large central plant, and transmitted electrically to the numerous and scattered points of actual application. The utilization of this method by Swift & Company, the world's largest packers, is worthy of note. This concern has a number of plants in which electric power transmission is used to a greater or less extent, but the most complete installations are located in the Chicago and St. Joseph (Mo.) houses.

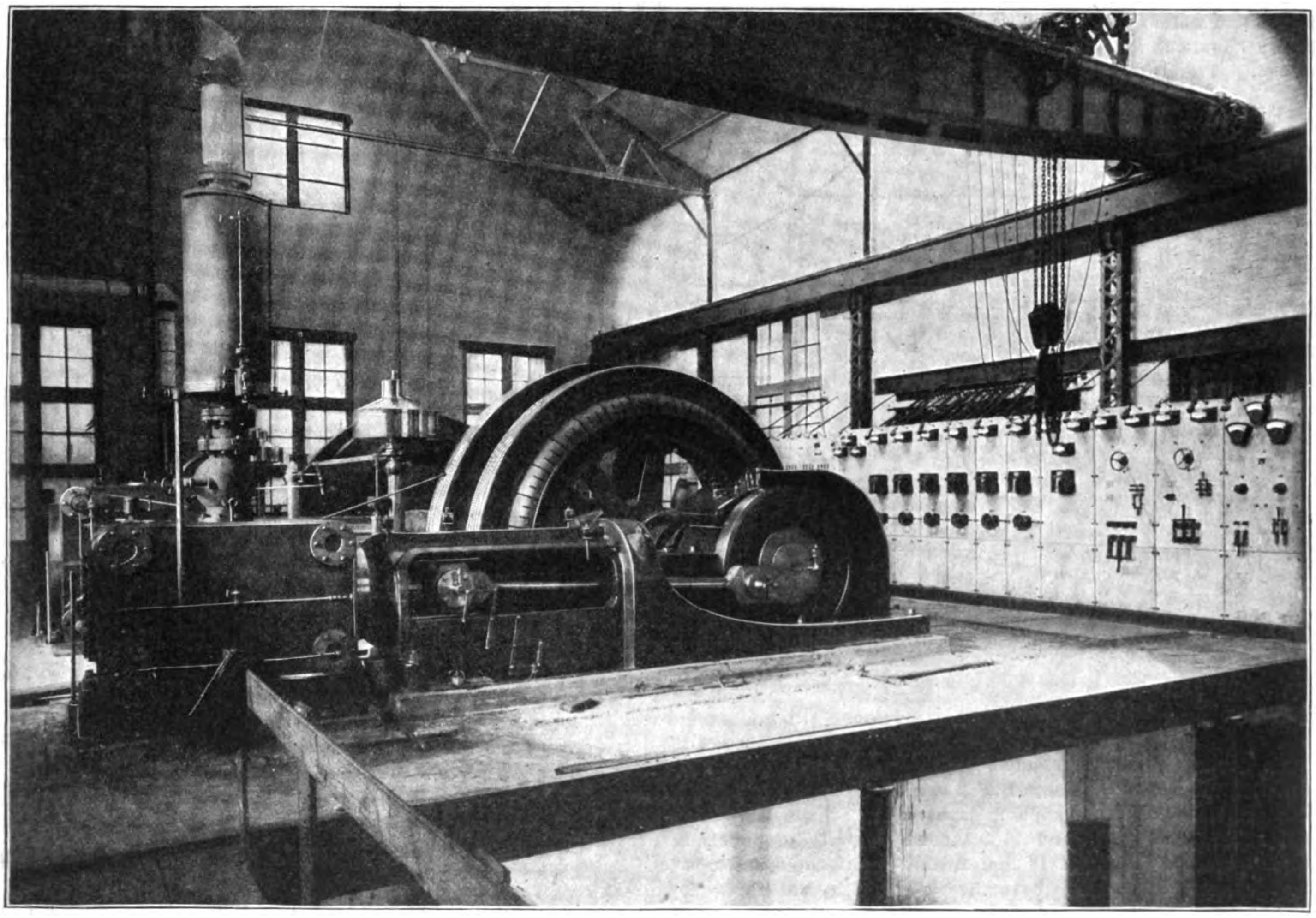


FIG. 1.—THE PRESENT ENGINES, GENERATORS AND SWITCHBOARD OF THE CHICAGO PLANT.

CHICAGO PLANT.

The packing plant covers 48 acres. Many of the buildings thereon are several stories in height. This fact alone would be enough to make the advantage of electric transmission apparent, and it is still more emphasized when it is known that there were formerly thirteen independent steam plants, eleven of which will be done away with by the establishment of the central electric generating plant here described. A large packing plant of this kind is really an aggregation of different kinds of factories all put under one management on one tract of land. In addition to the slaughtering, refrigerating and packing of the meat there are numerous by-product factories for butterine, soap, glue, fertilizers, etc.

Owing to local conditions and surrounding buildings the new central power station had to be divided, the boiler house being on one side of a couple of railroad tracks and the stack and engine room on the other side. The fuel economizers are in the smoke flues over the railroad track, the elevation being such that cars can pass under. The plans of various parts of the steam plant can be seen from the accompanying drawings. Beginning with the coal on the siding between the boiler room and stack we find it being taken up into storage bins above the boilers by Link-Belt Machinery Company's conveyors. These conveyors return beneath the ash pits under the boilers so that they can also be used for carrying away ashes, by opening the trap doors in the floors of the ash pits and letting the ashes fall on the conveyors. The coal conveyors can be made to run the coal through an electrically-driven coal crusher or it can be shunted around the crusher as desired. From the storage hoppers the coal is fed to automatic stokers built by the Murphy Iron Works, Detroit, Mich. Here it is worth while to note what the centralizing of power generation into large plants with automatic stokers is gradually accomplishing in the stock yards at Chicago. The packing houses in the Chicago Union Stock Yards have long been the worst smoke nuisances of that smoky city; the stack of the large central plant with automatic stokers is practically smokeless and forms an object lesson for less progressive establishments.

The boiler plant comprises eight 400-h.p. Babcock & Wilcox water-tube boilers. They are fed with Blake Admiralty-type pumps in duplicate, compound condensing with steam cylinders 7 and 14 ins. and water cylinders 7 ins. x 12 ins. stroke. The plant has a cooling tower for condensing water, and to circulate this a Blake simplex compound-condensing pump is used with steam cylinders 8 and 16 ins., and water cylinders 18 ins. x 18 ins. stroke. The economizers, located above the railroad tracks, as mentioned before, are of the Green type made by the Fuel Economizer Company, of Matteawan, N. Y. The stack is the second highest in the city; a sectional view of it is given by Fig. 3. Its height is 264 ft., inside diameter 16½ ft., base 26 ft. square. Its foundation is on 125 piles 30 ft. long. The cooling tower for furnishing condensing water is on top of the boiler house, as shown in Fig. 2. The condensers are of the siphon type. Two engine-generator sets are now installed and there is room for a third one, as shown in Figs. 1 and 5. The engines are notable as having a rather high speed for the type and size. They are cross-compound Corliss engines and are run condensing, with 150 lbs. boiler pressure. One engine is 13 and 26 ins. x 42 ins. stroke, direct-connected to a 300-kw. three-phase 250-volt alternator, running at 120 revolutions per minute; it is provided with a 32,000-lb. fly-wheel. The other engine is 19 and 38 ins. x 42 ins. stroke, with a 60,000-lb. fly-wheel, and is direct-connected to a three-phase 250-volt 600-kw. generator; its speed is also 120 r.p.m. The engines were both built by the Filer & Stowell Company, of Milwaukee, Wis., and the generators are General Electric machines. The exciters are belted from the fly-wheels of the engines. The generators are arranged so as to be operated in parallel or separately.

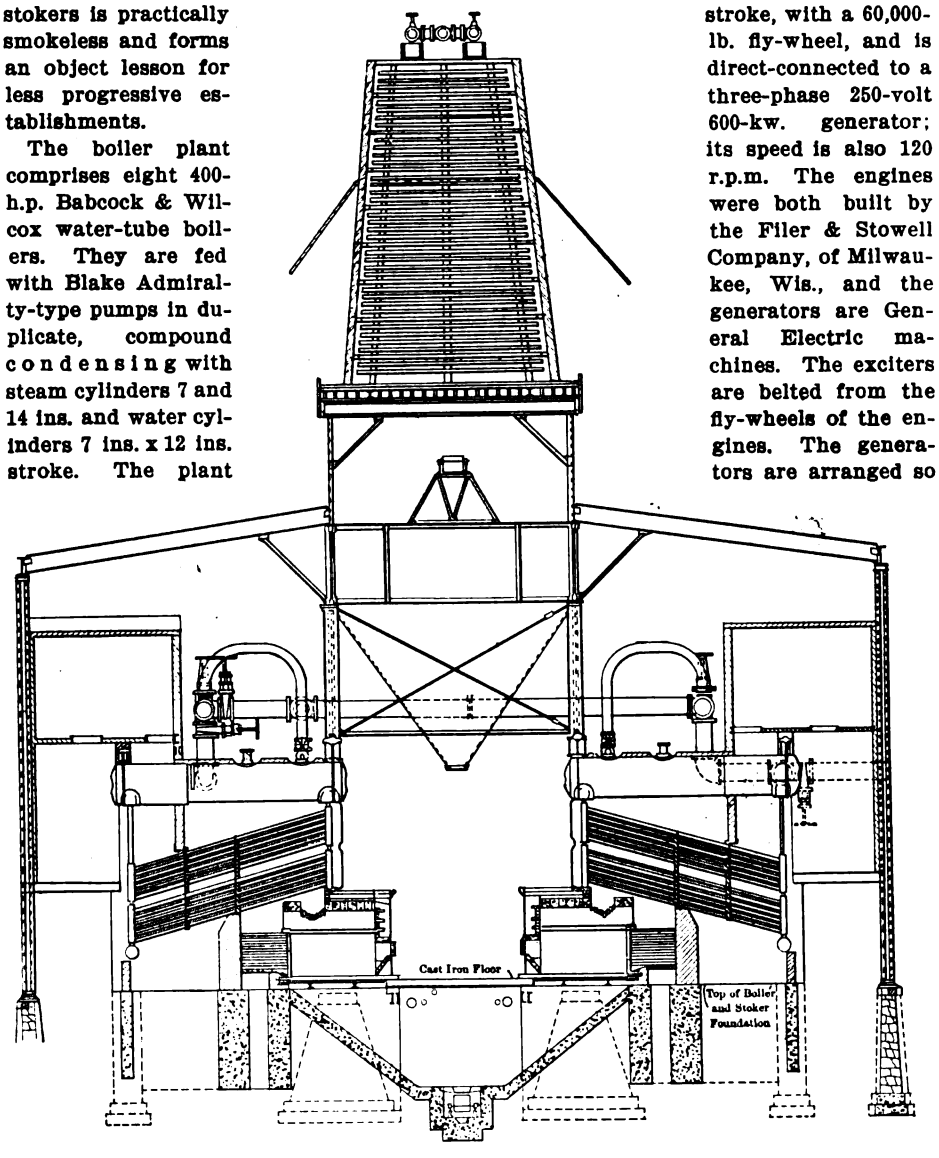


FIG. 2.—SECTION OF BOILER HOUSE AND COOLING TOWER.

The switchboard is an interesting piece of work, and necessarily has quite a variety of panels to provide for all the various operations to be accomplished with the three-phase service. The 250-volt three-phase currents are, of course, carried directly from the generators to the motors without transformation. Higher voltage was not used because of the danger to life from a higher voltage alternating current in such damp places as exist around packing plants. The marble switchboard has one panel devoted to the total output and for use in throwing generators together. It has two voltmeters, one for constant use, the other for testing the voltage of a generator that is to be thrown in; a recording Thomson wattmeter for the total output and a synchronizing voltmeter, the latter being an

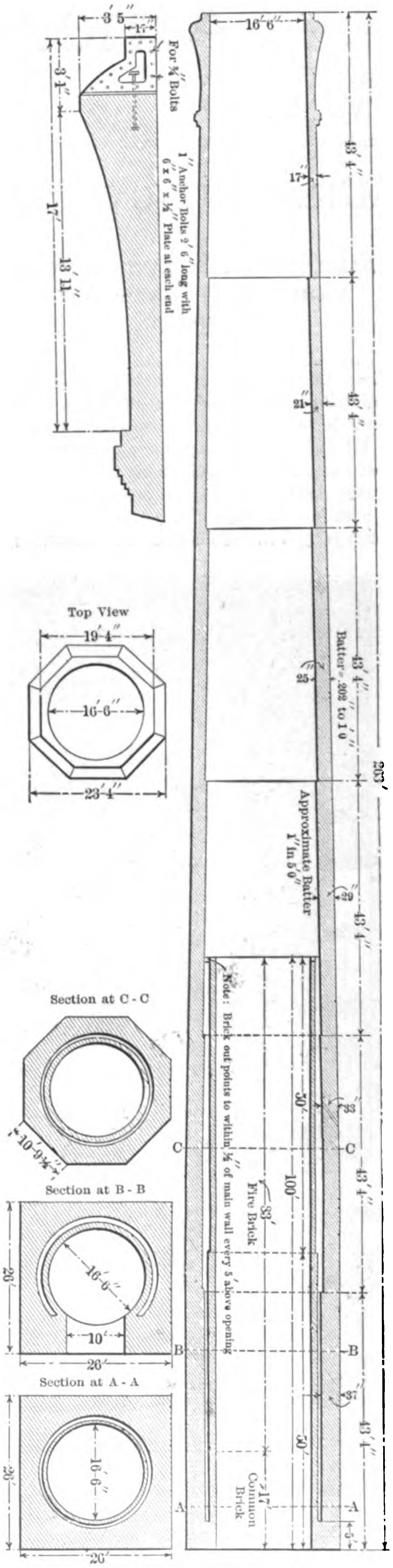


FIG. 3.—DETAILS OF CHIMNEY.

improvement on the old method of synchronizing with lamps. With lamps there is chance for a considerable change in phase without sufficiently dimming or brightening the lamps to make the difference in phase apparent to the attendant who is throwing the machines together. With a synchronizing voltmeter plugged in between two machines that are to be thrown together one may know exactly whether they are in step. The synchronizing voltmeter has a 700-volt scale.

Referring to the diagrams, Fig. 6 shows the connections of the arc and incandescent lighting sections of the board and Fig. 9 shows those of the generator, exciter and power feeder panels. The three bus-bars at the top of Fig. 6 are connected directly to those in Fig. 9 and the same is true of the three leads at the bottom of Fig. 6 marked "To 300-kw. generator," and the three at the bottom of Fig. 9 marked "Leads to Incandescent Lighting Board." These latter leads allow the incandescent circuits to be supplied either directly from the 300-kw. machine or from the general bus-bars. The arc lighting

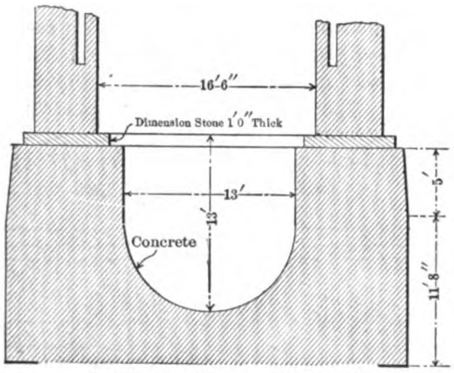


FIG. 4.—SECTION OF CHIMNEY BASE.

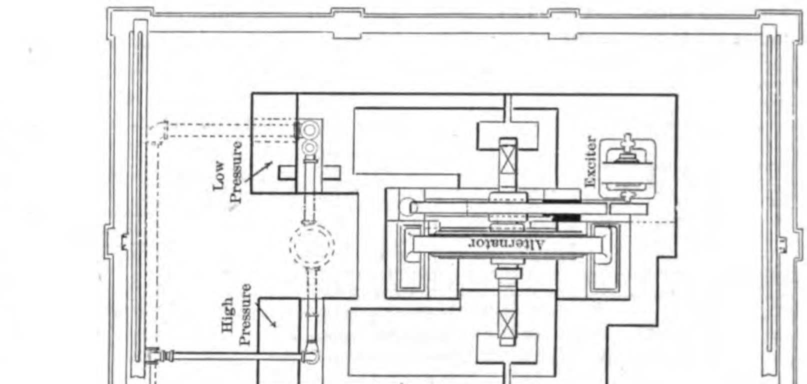
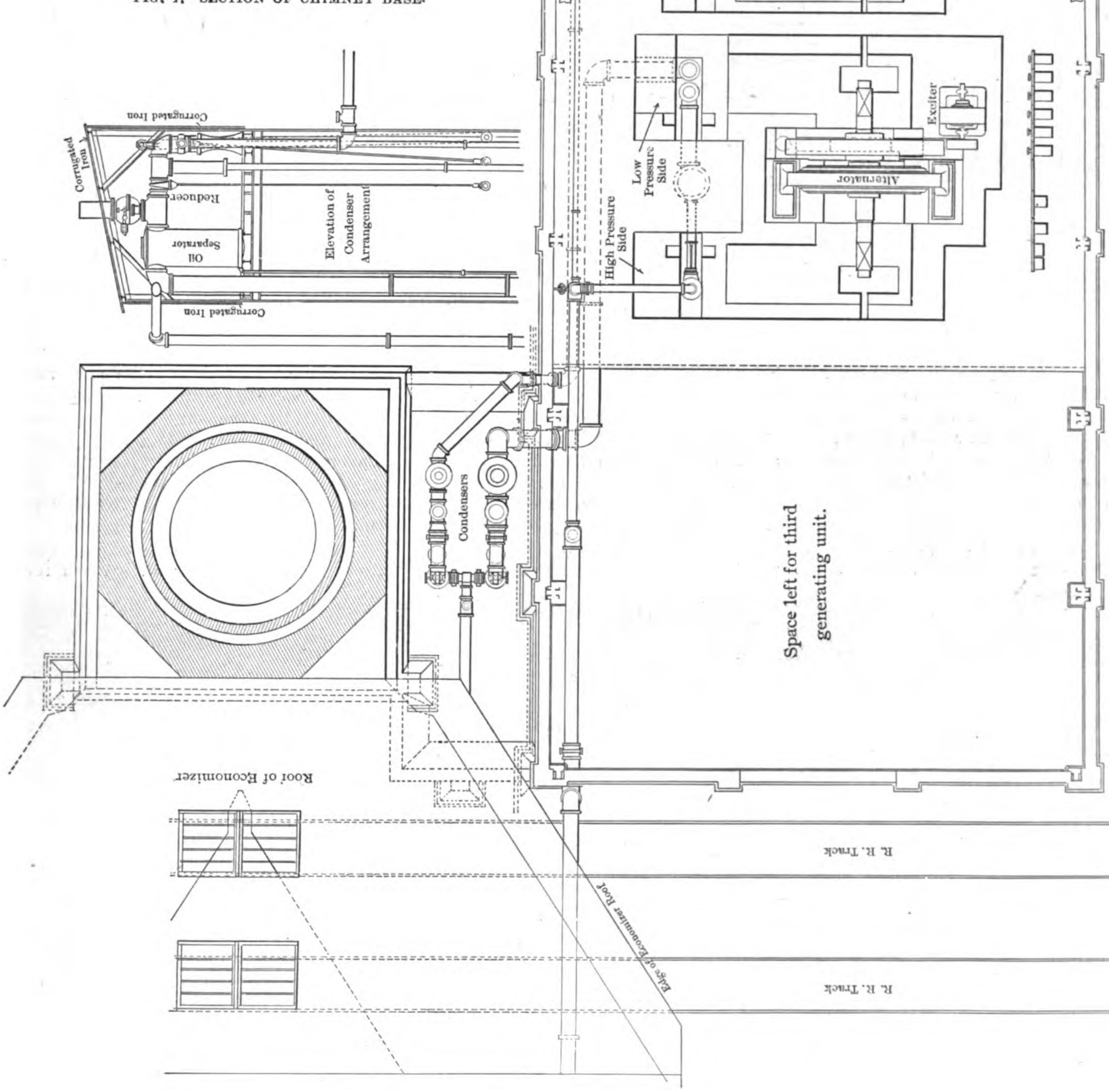



FIG. 5.—PLAN OF THE CHICAGO POWER HOUSE; WITH ELEVATION OF CONDENSER PLANT IN UPPER PART OF ENGRAVING.

transformers are supplied only from the general bus-bars. They are ordinary constant-potential apparatus, of 30 kilowatts capacity each, and were built by the Wagner Electric Manufacturing Company, of St. Louis, Mo.

The generator panels have each an indicator ammeter and wattmeter at the top, a field rheostat, a synchronizing plug for connecting the generator to the synchronizing voltmeter, a voltmeter switch, a main three-pole knife switch, and a 200-ampere field circuit switch. The latter has an arrangement for shunting the field through a non-inductive resistance as soon as the supply circuit is opened. There are six feeder panels for power circuits, each one having an ammeter, a recording wattmeter, and an oil switch, the mechanism of which is behind the board. All the switchboard instruments are of General Electric manufacture with horizontal scales. There is also a panel for the exciter dynamos, shown in Fig. 8.

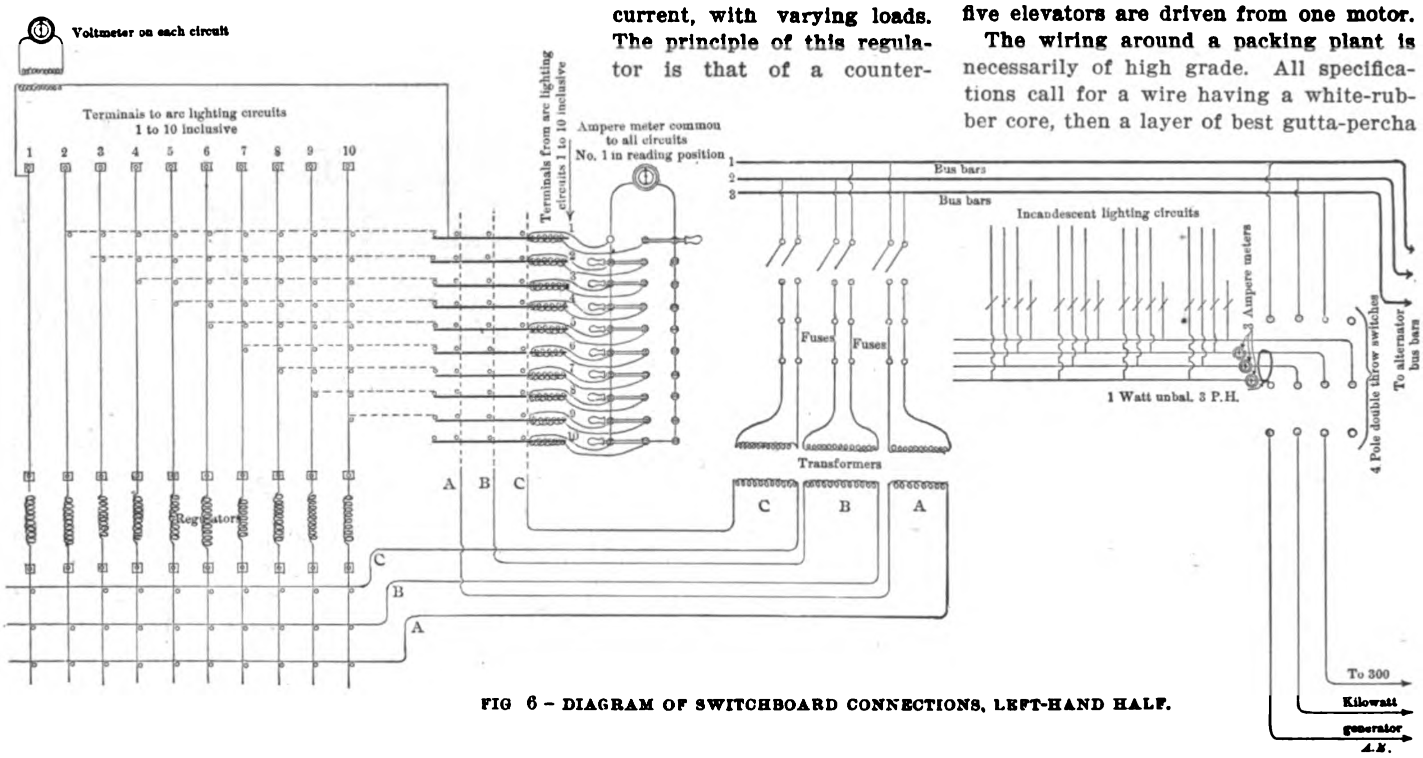

Voltmeter on each circuit
Terminals to arc lighting circuits 1 to 10 inclusive
1
2
3
4
5
6
7
8
9
10
Regulators
A
B
C
Terminals from arc lighting circuits 1 to 10 inclusive
Ampere meter common to all circuits No. 1 in reading position
1
2
3
Bus bars
Bus bars
Incandescent lighting circuits
Fuses
Fuses
Transformers
C
B
A
3 Ampere meters
1 Watt unbal. 3 P.H.
4 Pole double throw switches
To alternator bus bars
To 300 Kilowatt generator
A.E.

FIG 6 – DIAGRAM OF SWITCHBOARD CONNECTIONS, LEFT-HAND HALF.

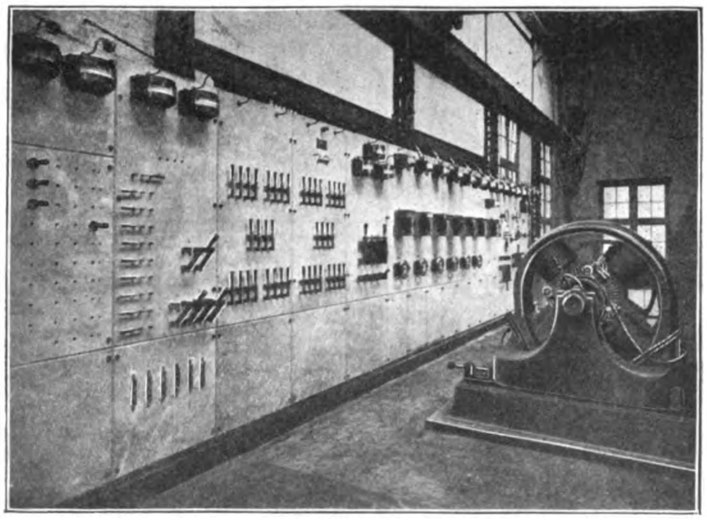


FIG. 7.—ARC LIGHTING AND INCANDESCENT LIGHTING PANELS.

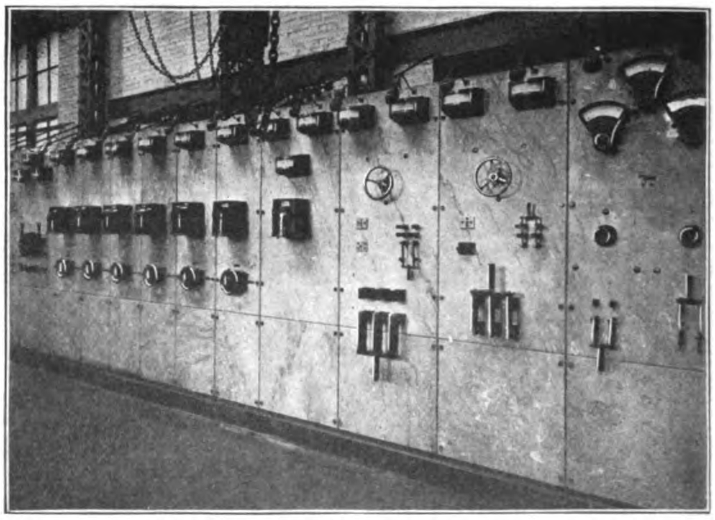


FIG. 8.—FEEDER, GENERATOR AND EXCITER PANELS.

One of the interesting features of the new plant is the extensive use of enclosed alternating-current series arc lamps. Manhattan arc lamps were the ones selected. From each of the three 30-kw. Wagner transformers two arc circuits are run. Each circuit has a Manhattan regulator for maintaining constant current, with varying loads. The principle of this regulator is that of a counter-balanced solenoid in the circuit to be regulated which is drawn down a varying distance over an iron core as the number of lamps in circuit varies. Two circuits are run in parallel off each transformer, and no circuit includes more than 20 lamps. The current is 6.8 amperes. An arc-circuit plug board is provided for the arc circuits so that when not many lights are in use they can be put all on one transformer to avoid running the other transformers underloaded. The arc-circuit boards have voltmeters calibrated to read in lamps and in volts.

The station has connected to it about 1800 horse-power in motors, 10,500 incandescent lamps and 150 arc lamps. It is hardly necessary to enumerate the various uses of these motors, but among the important uses are for conveyors and elevators. All motors are of the constant-speed type, no success having been made of this company's attempt to secure variable-speed polyphase motors. In one case five elevators are driven from one motor.

The wiring around a packing plant is necessarily of high grade. All specifications call for a wire having a white-rubber core, then a layer of best gutta-percha composition, a layer of tape and two braids separately saturated. American Steel & Wire Company's wire has been used. All wires are run on glass or porcelain insulators.

THE ST. JOSEPH PLANT.

The packing plant of the company at South St. Joseph, Mo., is a comparatively new one and has had electric transmission throughout since the start. When the plant was first installed it was the smallest of this company's plants; it has since had a remarkably rapid growth and is now second in size only to the Chicago plant. It is a combination refrigerating and electric power plant. Babcock & Wilcox water-tube boilers are used, half of them being hand fired and the other half, which were recently installed, being fitted with the Green Engineering Company's chain grates. There are two steel stacks, one 166 ft. high and 8 ft. in diameter, the other 166 ft. high and 10 ft. in diameter. Ash conveyors made by the Link-Belt Machinery Company run directly under the ash pits the whole length of the boiler room. An interesting set of tests was being carried on at the time the writer visited the plant, the object of which was to determine which fireman was the most skillful, and incidentally to enable the firemen to intelligently improve the general quality of their work. One boiler was set aside for testing purposes and the firemen took turns firing the test boiler a day at a time; a record of each man's work was kept and posted.

This boiler plant has economizers in the flues, of a type designed by Swift & Company's engineers. The hot water from these economizers is used not only for feeding the boilers, but for the entire packing plant, which requires considerable hot water. The engines of the plant are run condensing, with water supplied from numerous artesian wells, but the discharge from the condensers is all used around the packing house, hence no cooling tower is needed for this. This artesian-well water is all pumped by triplex pumps geared to large Westinghouse two-phase induction motors. The motors were originally geared to the pumps with double-reduction gears, but the noise of the motor gears caused the engineers to discard them. The motors are now belted to the intermediate shafts, and these are geared to the pump shafts.

The power plant now has three electrical units. The first two units consisted of Filer & Stowell engines driving Westinghouse two-phase alternators. One compound-condensing engine with cylinders 14 and 26 ins. in diameter by 36 ins. stroke drives a 180-kw. alternator, and another engine of the same type with cylinders 16 and 30 ins. in diameter by 36 ins. stroke drives a 250-kw. alternator; both engines run at 95 r.p.m. Rope drive is used in this plant on all three units.

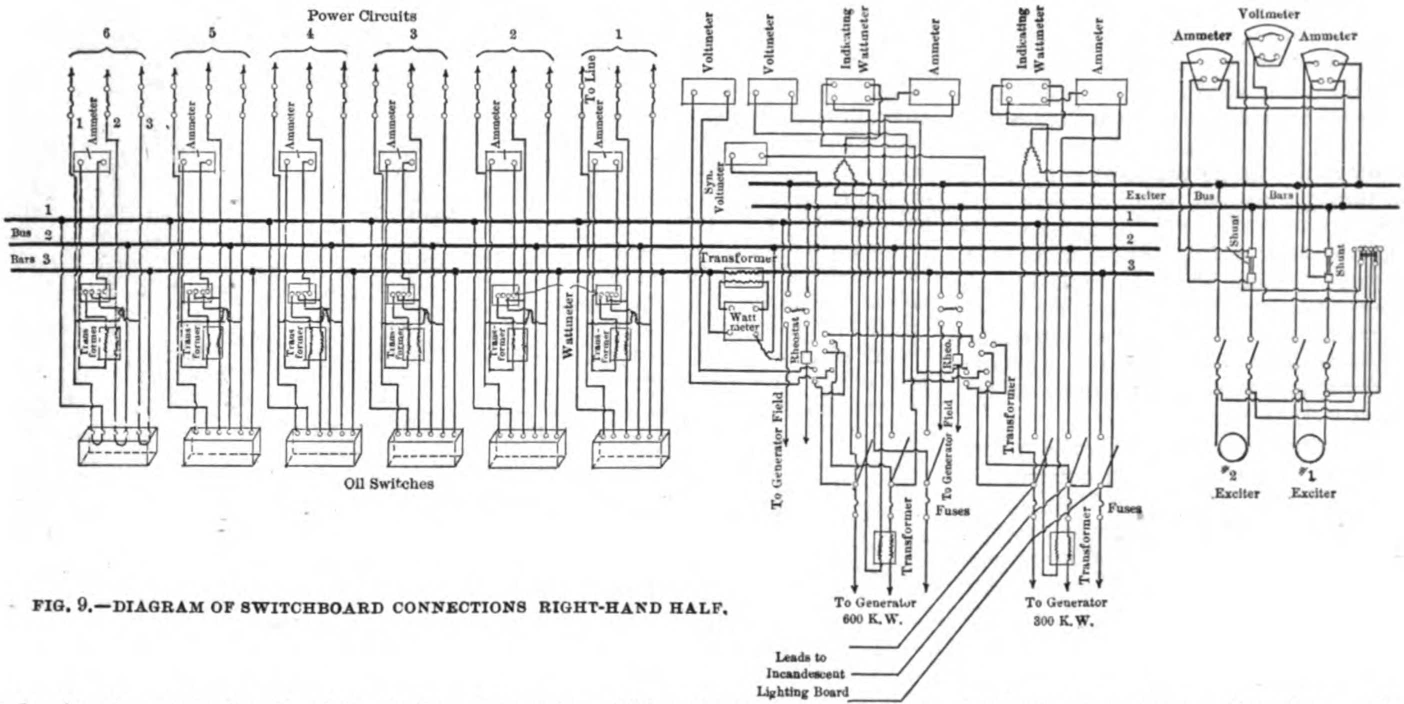


FIG. 9.—DIAGRAM OF SWITCHBOARD CONNECTIONS RIGHT-HAND HALF.

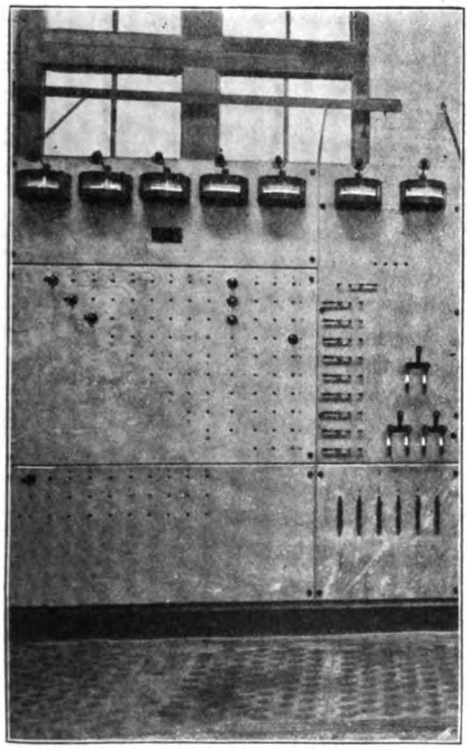


FIG. 10.—ARC-CIRCUIT SWITCHBOARD.

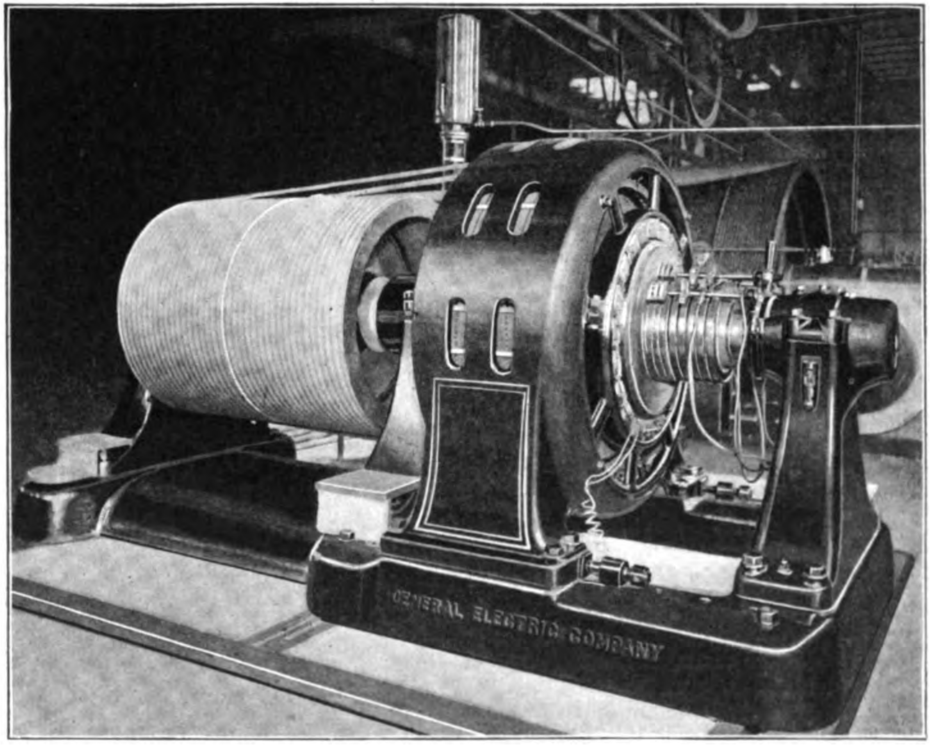


FIG. 11.—500-KW. COMPENSATED-FIELD ALTERNATOR IN ST. JOSEPH PLANT.

The two Westinghouse alternators just mentioned have compounded fields. The latest addition is a Filer & Stowell engine with cylinders 21 and 40 ins. x 42 ins. driving a General Electric 500-kw. two-phase alternator of the new compensated-field type, having the exciter armature on the main shaft between the collector rings and the armature; this machine is shown in Fig. 11. This machine runs at 360 r.p.m.; although of different make and design from the other alternators (being the revolving-field type and the others having revolving armatures), this new machine is run in parallel with the other two. The smallest alternator has a double-throw switch on its panel, whereby it can be thrown onto the lights alone or onto the main bus-bars; thus the lights can be supplied direct or from the main bus-bars. During the day when there is enough power in use to give an economical load to one or two generators it is desirable to run the lights separately on one generator to avoid the fluctuations caused by the power circuits.

The switchboard has a power feeder panel for each one of seven different departments and each one of these panels has a Westinghouse ammeter and recording wattmeter, the amount of power used being charged up against each department. A recording instrument is put in each phase. There are also two recording wattmeters for the total output. There are about 100 motors, aggregating 1000 horse-power, around this plant, and 50 General Electric enclosed arc lamps. The voltage of the plant is 220. An important use of motors is for freight elevators. Some of these elevators are run by a friction device, the motor running constantly. Another interesting type is one in which the motor is geared to the winding drum, like a direct-current motor, and the motor is started and stopped with the elevator. The voltage is reduced with an ordinary transformer to about 140 and the current is thrown directly on at this pressure. The motors are 15-h.p. machines, built for heavy temporary overload and take 36 horse-power at the instant of starting. Although the fluctuation is a drawback, it does away with the constant running of a motor and consequent waste of power with the friction-gear elevator. The control apparatus of the reversing type of elevator is very simple and one of the elevator motors and machines is shown herewith. The movement of the elevator-controlling cable to start the car releases a mechanical brake and turns the motor controller drum to the "on" position. This operation is reversed when the car is stopped.

The plants were both designed and installed by the Construction and Mechanical Department of Swift & Company, and are a credit to all concerned. Mr. H. C. Gardner is manager of these departments, and George M. Brill, now a consulting engineer of Chicago, was assistant manager at the time these plans were designed and installed and gave special attention to this work.

ELECTRICAL ILLUMINATION AND FOUNTAINS AT THE PAN-AMERICAN EXPOSITION.

It was decided at the outset that illumination at the Pan-American Exposition, soon to be opened at Buffalo, should be accomplished exclusively by incandescent electric lamps of 8 candle-power and 16 candle-power; consequently no arc lights, acetylene gas or illuminating gas lamps will be used in the decorative illumination, it being considered impracticable to enter these lights in competition with each other for this class of work. The scheme of lighting at the Exposition will depend for its success on the exceptionally advantageous arrangement of the buildings with reference to the enclosed courts, in the shape of an inverted "T." This makes it possible to obtain a gradual increase of illumination leading toward the stately Electric Tower which stands at the base of the "T," and which is to furnish the climax of the display at night. The number of lights and the quantity of light will exceed that of any other equal area ever artificially illuminated.

It is stated that unusual spectacular effects will be produced by the many combinations of light and water and these combinations are to be so graded as to be in keeping with the decorative lights of the Electric Tower, while the Tower basin will be the stage of the display for electric fountains using 1,500,000 gallons of water an hour and illuminated by a hundred powerful searchlights. The open courts about the grounds are to be illuminated by incandescent lamps mounted on nearly 2000 columns, each carrying from 25 to 100 lamps. Part of these columns will be wired for all-night lamps and others for service only during certain hours of the evening. The staff-covered columns will be 9 ft. high, and columns three times this

FIG. 2.—SYMBOLIC FIGURE ON TOWER.

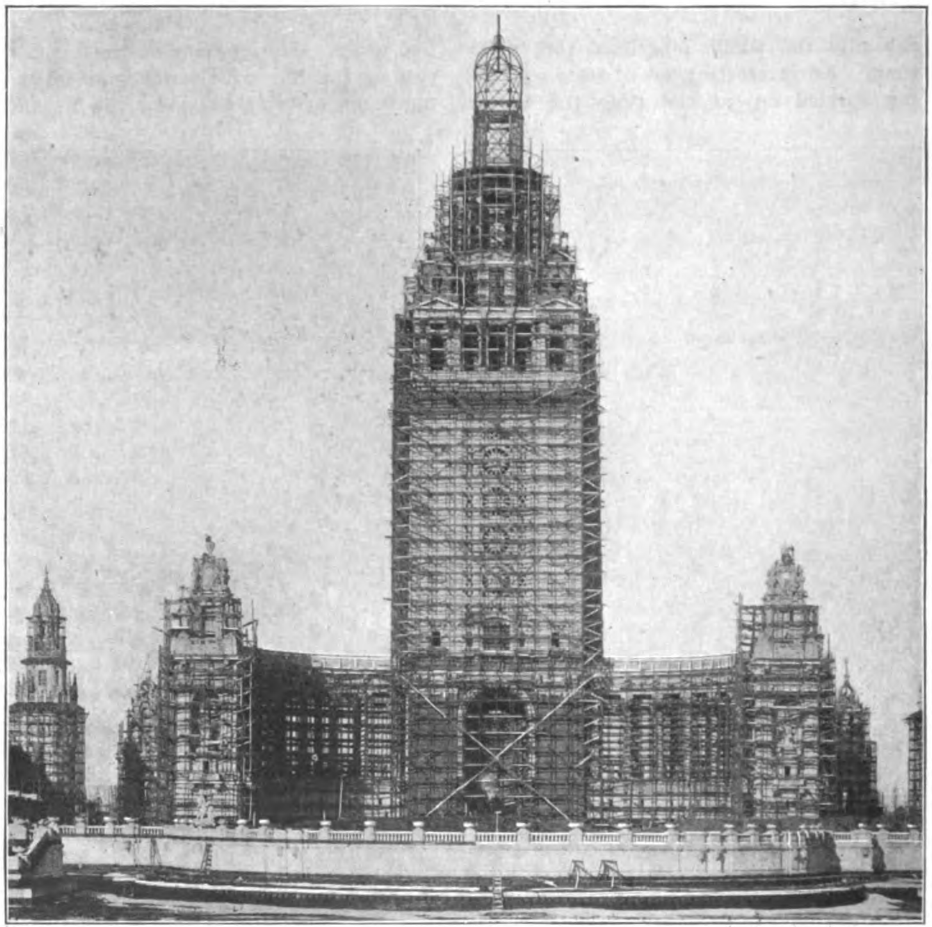


FIG. 1.—ELECTRIC TOWER, PAN-AMERICAN EXPOSITION.

height will be used at each of the entrances to the principal avenues.

Entering the main Lincoln Parkway gate one sees a pretty lake on the right, with banks covered by trees, plants and flowers, lighted by concealed incandescent lamps as in the sunken gardens at the right and left of the forecourt. Over to the left from the bridge may be seen the artistically-arranged artificial rock work of the base of the electric fountain, which is to be nearly 200 ft. long and 100 ft. wide, occupying a central position in a little sheet of water about a fifth of a mile across. The chamber from which the water and lighting effects will be controlled is located below the artificial rock work and the current for operating the various pumps and arc light projectors will be carried by underground cables. The fountain at the North Bay is to be operated only from fifteen minutes to half an hour each evening, but it will be well worth a visit as there will be many color effects which have never before been attempted.

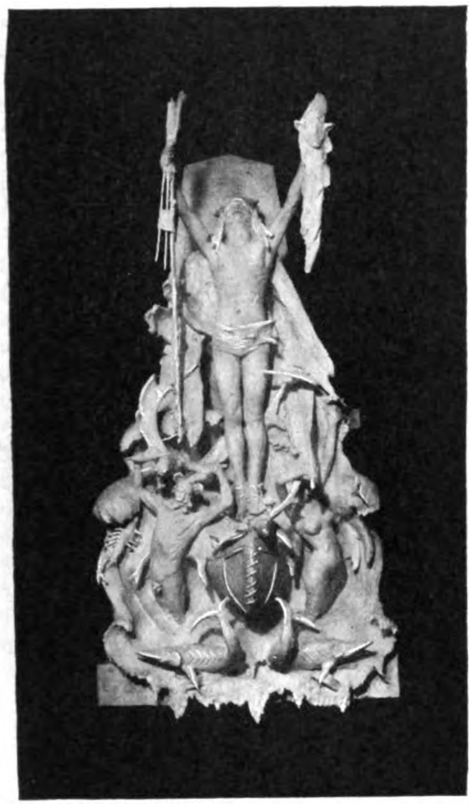


FIG. 3.—SYMBOLIC GROUP ON TOWER.

Nearly a dozen different pumping schemes are to be employed, with water pressures of 50 lbs. and 150 lbs. Westinghouse 500-volt motors will drive two Root pumps, which will supply water at 150 lbs. and 50 lbs. pressure, respectively. The high-pressure pump will supply the "grand geyser," which will throw a stream nearly as large as a man's wrist 250 ft. high, forming the highest jet of the fountain. It will be operated alone and in combination with ring curtains, fog bank, fan jets of various shapes and numerous other designs, such as sheaves of wheat, lilies of pure white and varied colors. Twenty-two orifices will be equipped with 20-ampere Bogue focusing arc lamps specially designed for this purpose.

After leaving the illuminated fountain in the North Bay, the spectacle will increase in grandeur as the visitor crosses the forecourt and bridge and enters the esplanade and Court of Fountains, and the water and light effects will reach a maximum at the Electric Tower. From a point high up in a niche of the tower more than half a million gallons of water an hour will pour out, striking a curved deflector and steel lip and breaking into an immense screen, behind which several powerful projectors will send lights of various hues through the falling sheet of water. There will be 26 pillar jets of changing color, each stream reaching 40 ft. in height, while about 50 other large jets will throw parabolic streams of water into the cascades in front of the tower niche.

The Electric Tower, which is nearly completed, is shown by Fig. 1. Many beautiful pieces of statuary have been prepared for the Tower, one of which is intended to represent "The Great Waters in the Days of the Indians," and is illustrated by Fig. 3. Another piece, shown by Fig. 2, represents "Lake Erie."

The pumping plant will be in the Machinery and Transportation Building; 2,000,000 gals. of water an hour will be required and this will be supplied by a dozen or more Root pumps operated by American, Ames, Fitchburg, Harrisburg, Watertown and other well-known makes of engines, and the motors mentioned above. The fountains will be supplied at 110 lbs. pressure through 16-in. and 20-in. mains, while the intake at the Court of Fountains will be 4 ft. in diameter.

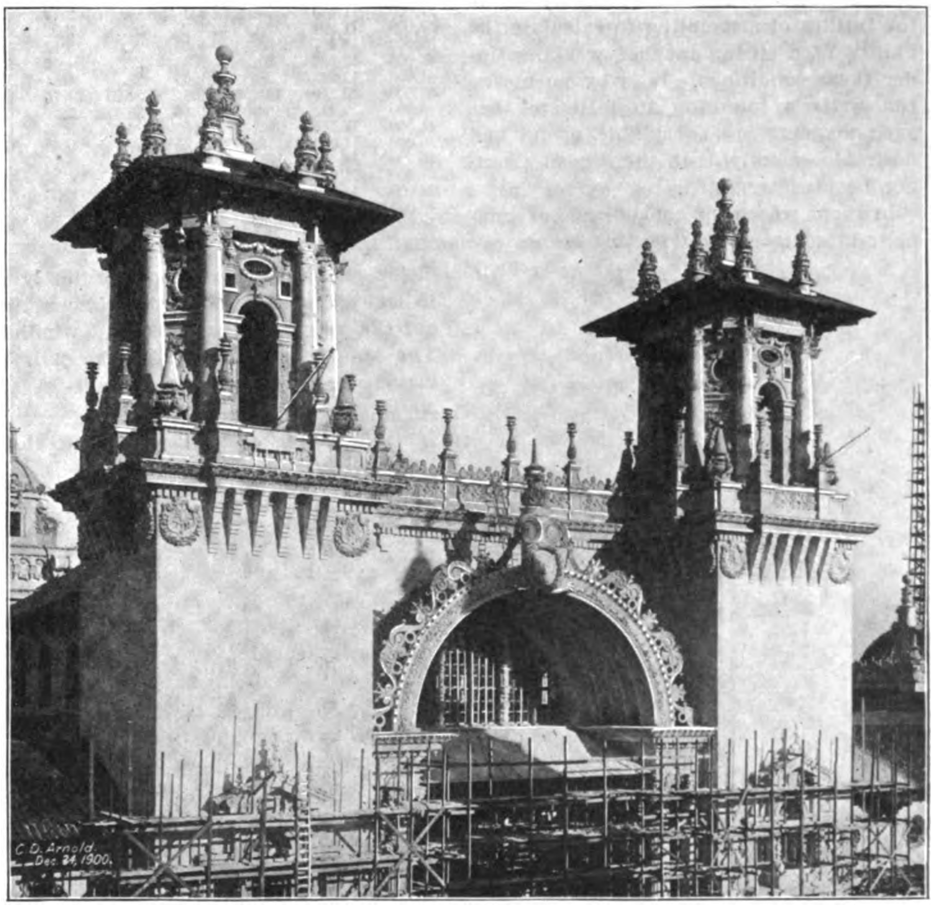


FIG. 4.—COMPLETED TOWERS OF ELECTRICITY BUILDING.

ELECTROMAGNETS AND SOLENOIDS.

In order to construct an electromagnet or a solenoid intelligently, the service which it is to perform must be the prime consideration. This statement may seem trite to some readers, but the fact is that a very large proportion of the electromagnets that one finds in use are built almost without regard to their mechanical functions.

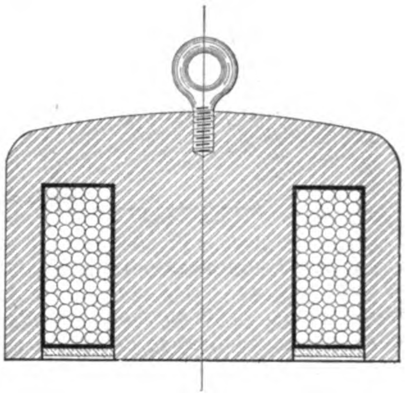


FIG. 1.—IRONCLAD MAGNET.

The subject of electromagnets for lifting such objects as iron plates was so fully considered in recent articles* that there is little left to be said. Such magnets operate under the disadvantage of a variable and indeterminable air-gap reluctance. Unless the surface of the object to be lifted has been planed off, the area of actual contact surface cannot be predetermined, and the magnet must be made many times more powerful than a calculation based on zero air-gap would prescribe. The magnet represented by Fig. 1 herewith and described in Mr. Clark's second article will serve to illustrate this statement. This magnet had a pole-face area of 204 sq. ins. and lifted 24,000 pounds. The magnetic density at the pole-faces required to do this, according to Maxwell's formula for the law of traction, is 108,460 lines per square inch, ignoring leakage.

---

*Lifting Electromagnets, by E. B. Clark, American Electrician for December, 1900, and February, 1901.

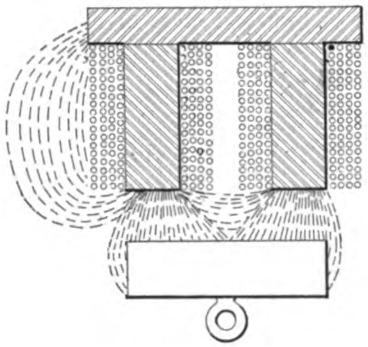


FIG. 2.—ORDINARY MAGNET.

If the plate lifted by the magnet had polar surface and of a cross-section equal to that of the magnet core, the ampere-turns required to produce this degree of saturation would have been from 6000 to 8000, according to the magnetic quality of the magnet core; in actual experiment, however, 37,750 ampere-turns were required. This is sufficient to demonstrate the futility of attempting to calculate the ability of a lifting magnet working under these conditions. It is by no means the writer's intention to intimate that such magnets are not highly useful and desirable—merely that their power cannot be predetermined.

In shops where the convenience of magnetic attachments to traveling cranes can be made to justify the expense of using them for carrying objects of an irregular surface which cannot be picked up without the intervention of an armature, the ability of the magnet can be closely approximated without resort to cut-and-try methods. Tables I and II give the theoretical lifting power of magnets at different pole-face densities, figured on the assumption that the armature touches every part of the pole-face surface. When lifting armatures are employed, this condition can be approximated so closely as to make these tables of value in working out the magnet dimensions and winding. The column which gives the pull in pounds per square inch of pole-face is figured for total pole-face area, not for the area per pole. The columns giving the pull with round cores of different diameters are figured for a single pole; consequently, for a horseshoe magnet the figures should be doubled to get the total pull on the armature.

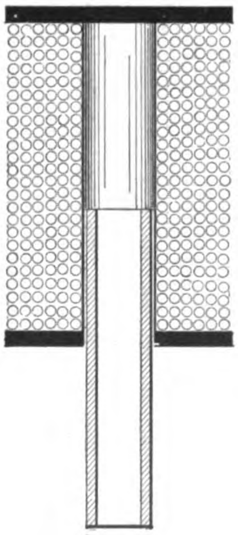


FIG. 3.—SIMPLE SOLENOID.

TABLE I.—AMPERE-TURNS AND TRACTIVE POWER OF ELECTROMAGNETS AND STOPPED SOLENOIDS.

Magnetic density per sq. in.	Ampere-turns per inch of length. Air.	Cast iron.	Cast steel.	Pull in lbs. per sq. in.	Pull in pounds, per pole, by round cores. ½ in.	9/16 in.	⅝ in.	11/16 in.	¾ in.	13/16 in.	⅞ in.	15/16 in.	1 in.
10,000	3133	18.	3.7	1.38	.27	.34	.42	.51	.61	.71	.83	.95	1.08
10,500	3290	18.6	3.75	1.5	.29	.37	.46	.55	.66	.77	.9	1.03	1.17
11,000	3447	19.2	3.81	1.65	.32	.41	.50	.61	.73	.85	.99	1.13	1.29
11,500	3603	19.8	3.87	1.8	.35	.44	.55	.66	.79	.93	1.08	1.24	1.41
12,000	3760	20.4	3.93	2.	.39	.49	.61	.74	.88	1.03	1.2	1.38	1.57
12,500	3917	21.	3.99	2.15	.42	.53	.66	.79	.95	1.11	1.29	1.48	1.68
13,000	4073	21.6	4.05	2.3	.45	.57	.70	.85	1.01	1.19	1.38	1.58	1.8
13,500	4230	22.2	4.11	2.5	.49	.62	.76	.92	1.1	1.29	1.5	1.72	1.96
14,000	4387	22.8	4.17	2.7	.53	.67	.82	1.	1.19	1.4	1.62	1.86	2.12
14,500	4543	23.4	4.23	2.9	.56	.72	.89	1.07	1.28	1.5	1.74	2.	2.27
15,000	4700	24.	4.3	3.1	.61	.77	.95	1.15	1.37	1.6	1.86	2.14	2.43
15,500	4857	24.6	4.37	3.3	.64	.82	1.01	1.22	1.45	1.71	1.98	2.27	2.59
16,000	5013	25.2	4.44	3.5	.68	.87	1.07	1.3	1.54	1.81	2.1	2.41	2.74
16,500	5170	25.8	4.51	3.75	.73	.93	1.15	1.39	1.65	1.94	2.25	2.58	2.94
17,000	5326	26.5	4.58	4.	.78	.99	1.22	1.48	1.76	2.07	2.4	2.76	3.14
17,500	5483	27.2	4.65	4.25	.83	1.05	1.3	1.57	1.87	2.2	2.55	2.93	3.33
18,000	5640	27.9	4.72	4.5	.88	1.11	1.38	1.67	1.98	2.33	2.7	3.1	3.53
18,500	5796	28.6	4.79	4.75	.93	1.18	1.45	1.76	2.09	2.46	2.85	3.27	3.73
19,000	5953	29.3	4.86	5.	.98	1.24	1.53	1.85	2.2	2.59	3.	3.45	3.92
19,500	6110	30.	4.93	5.25	1.03	1.3	1.61	1.94	2.32	2.72	3.15	3.62	4.12
20,000	6266	30.7	5.	5.5	1.08	1.36	1.68	2.04	2.43	2.85	3.3	3.79	4.32
20,500	6423	31.4	5.08	5.75	1.13	1 42	1.76	2.13	2.54	2.98	3.45	3.96	4.51
21,000	6580	32.2	5.16	6.	1.17	1.49	1.84	2.22	2.65	3.11	3.6	4.14	4.71
21,500	6736	33.1	5.24	6.4	1.25	1.59	1.96	2.37	2.82	3.31	3.84	4.41	5.02
22,000	6893	34.	5 32	6.7	1.31	1.66	2.05	2.48	2.96	3.47	4.02	4.62	5.26
22,500	7050	35.	5.4	7.	1.37	1.74	2.14	2.59	3.09	3.63	4.2	4.83	5.49
23,000	7206	36.	5.48	7.3	1.43	1.81	2.24	2.71	3.22	3.78	4.39	5.03	5.75
23,500	7363	37.	5.56	7.6	1.49	1.88	2.33	2.82	3.35	3.94	4.57	5.24	5.96
24,000	7520	38.	5.64	7.9	1.55	1.96	2.42	2.93	3.49	4.09	4.75	5.45	6.2
24,500	7677	39.	5.72	8.3	1.63	2.06	2.54	3.08	3.66	4.3	4.99	5.72	6.51
25,000	7833	40.	5.8	8.6	1.68	2.13	2.63	3.19	3.8	4.45	5.17	5.93	6.75
26,000	8146	42.	5.97	9.3	1.82	2.31	2.85	3.45	4.1	4.82	5.59	6.42	7.3
27,000	8459	44.	6.14	10.	1.96	2.48	3.06	3.71	4.41	5.18	6.01	6.9	7.85
28,000	8773	46.	6.32	10.8	2.12	2.68	3.31	4.	4.77	5.6	6.49	7.45	8.48
29,000	9086	49.	6.5	11.6	2.27	2.88	3.55	4.3	5.12	6.01	6.97	8.	9.11
30,000	9400	52.	6.7	12.4	2.43	3.08	3.8	4.6	5.47	6.43	7.45	8.55	9.73
31,000	9713	55.	6.9	13.2	2.59	3.28	4.05	4.9	5.83	6.84	7.93	9.11	10.36
32,000	10,026	58.	7.1	14.	2.74	3.48	4.29	5.19	6.18	7.26	8.41	9.66	10.99
33,000	10,339	61.	7.3	15.	2.94	3.72	4.6	5.56	6.62	7.77	9.02	10.35	11.77
34,000	10,652	64.	7.5	16.	3.14	3.97	4.91	5.97	7.06	8.29	9.62	11.03	12.56
35,000	10,965	68.	7.7	17.	3.33	4.22	5.21	6.31	7.51	8.81	10.22	11.72	13.35
36,000	11,278	72.	7.9	18.	3.53	4.47	5.52	6.68	7.95	9.33	10.82	12.42	14.13
37,000	11,590	76.	8.1	19.	3.73	4.72	5.83	7.05	8.39	9.85	11.42	13.11	14.92
38,000	11,904	80.	8.3	20.	3.92	4.97	6.13	7.42	8.83	10.37	12.02	13.8	15.7
39,000	12,217	85.	8.55	21.	4.12	5.21	6.44	7.79	9.27	10.88	12.62	14.49	16.48
40,000	12,532	90.	8.8	22.	4.32	5.46	6.75	8.16	9.72	11.4	13.22	15.18	17.27
41,000	12,843	95.	9.05	23.	4.51	5.71	7.05	8.53	10.16	11.92	13.82	15.87	18.05
42,000	13,159	100.	9.3	24.25	4.76	6.02	7.44	9.	10.7	12.57	14.57	16.73	19.04
43,000	13,472	106.	9.55	25.5	5.	6.33	7.82	9.46	11.25	13.22	15.32	17.6	20.
44,000	13,785	112.	9.8	26.75	5.25	6.64	8.20	9.93	11.8	13.87	16.07	18.46	21.
45,000	14,098	118.	10.25	28.	5.49	6.95	8.59	10.09	12.35	14.51	16.82	19.32	22.
46,000	14,412	125.	10.5	29.3	5.75	7.28	8.99	10.87	12.95	15.18	17.61	20.22	23.
47,000	14,725	132.	10.8	30.6	6.	7.6	9.38	11.35	13.5	15.85	18.4	21.12	24.02
48,000	15,038	140.	11.15	31.9	6.26	7.92	9.78	11.84	14.09	16.53	19.17	22.	25.05
49,000	15,350	150.	11.5	33.2	6.52	8.25	10.18	12.32	14.65	17.21	19.95	22.91	26.07
50,000	15,665	160.	11.9	34.6	6.79	8.59	10.6	12.84	15.28	17.93	20.8	23.87	27.17

TABLE II.—AMPERE-TURNS AND TRACTIVE POWER OF HORSESHOE ELECTROMAGNETS.

Magnetic density per sq. in.	Ampere-turns per inch of length. Wro't iron.	Steel.	Pull lbs. per sq. in.	Pull in pounds, per pole, by round cores. ½ in.	9/16 in.	⅝ in.	11/16 in.	¾ in.	13/16 in.	⅞ in.	15/16 in.	1 in.
80,000	32	34	88.7	17.4	22.	27.2	32.9	39.1	45.9	53.3	61.2	69.6
81,000	33½	36	90.9	17.8	22.5	27.8	33.7	40.1	47.1	54.6	62.7	71.3
82,000	35	38	93.2	18.3	23.	28.6	34.6	41.1	48.3	56.	64.3	73.2
83,000	36½	40	95.5	18.75	23.7	29.3	35.4	42.1	49.5	57.4	65.9	75.
84,000	38	42	97.8	19.2	24.3	30.	36.3	43.2	50.7	58.8	67.5	76.8
85,000	40	44	100.	19.6	24.8	30.6	37.1	44.1	51.8	60.1	69.	78.5
86,000	42	46½	102.5	20.1	25.4	31.4	38.	45.2	53.1	61.6	70.7	80.5
87,000	44	49	104.9	20.6	26.	32.1	38.9	46.3	54.3	63.	72.4	82.3
88,000	46	51½	107.3	21.	26.6	32.9	39.8	47.4	55.6	64.5	74.	84.2
89,000	49	54	109.7	21.5	27.2	33.6	40.7	48.4	56.8	65.9	75.7	86.1
90,000	52	57	112.2	22.	27.8	34.4	41.6	49.5	58.1	67.4	77.4	88.1
91,000	55	60	114.7	22.5	28.5	35.1	42.5	50.6	59.4	68.9	79.1	90.
92,000	58	63	117.3	23.	29.1	36.	43.5	51.8	60.8	70.5	80.9	92.1
93,000	61½	66½	119.9	23.5	29.7	36.7	44.5	52.9	62.1	72.1	82.7	94.1
94,000	65	70	122.4	24.	30.4	37.5	45.4	54.	63.4	73.6	84.4	96.1
95,000	69	75	125.	24.5	31.	38.3	46.4	55.2	64.8	75.1	86.2	98.1
96,000	73	80	127.5	25.	31.6	39.1	47.3	56.3	66.1	76.6	88.	100.
97,000	77	85	130.4	25.6	32.4	40.	48.4	57.6	67.6	78.4	90.	102.
98,000	82	90	133.	26.	33.	40.8	49.3	58.7	68.9	79.9	91.8	104.
99,000	87	96	135.7	26.6	33.7	41.6	50.3	59.9	70.3	81.5	93.6	106.
100,000	92	102	138.5	27.	34.4	42.5	51.4	61.2	71.8	83.2	95.6	108.

Where it is desired to operate mechanism by means of an electromagnet, the ordinary form will not suffice unless the range of movement is extremely small, as in the case of telegraph instruments. An inspection of Fig. 2 will show why this is so; when the armature is moved far away from the poles the reluctance of the air-gap becomes so high that a large percentage of the flux leaks back around the outside of the coils into the yoke, and these lines exert no force upon the armature. A point is soon reached where the gap between the armature and the poles is so great that even with the magnet cores fully saturated, only a few magnetic lines go over to the armature, most of them going around the outside of the coils to the yoke; the result is that the pull on the armature is so reduced as to be useless. Hence it is that a magnet of the ordinary type is never employed by intelligent designers for actuating mechanism through a considerable range of movement.

An arrangement most commonly used for this class of work is the solenoid, or magnet coil, with a plunger core, as illustrated by Fig. 3. This is about the worst form possible, from an economical standpoint. The magnetic circuit is composed chiefly of air, and the result is that an enormous expenditure of electrical energy in the winding produces an insignificant amount of mechanical work at the plunger. A much better form is the ironclad solenoid shown by Fig. 4. Here, the magnetic circuit is chiefly iron, so that the efficiency is immensely higher than that of the simple solenoid of Fig. 3. In this construction the solenoid coil is provided with two short tubular cores, one at each end, between which there is an air-gap in the center of the coil. These cores are united on the outside of the coil by an iron shell, so that the only air-gap in the magnetic circuit is that in the interior of the coil where the field is very intense. This makes the air-gap itself use more energy than one in which the field might be more diffused, but as the gap is short, and as the remainder of the magnetic circuit is so much better than that of the old form shown by Fig. 3, the resultant efficiency is higher.

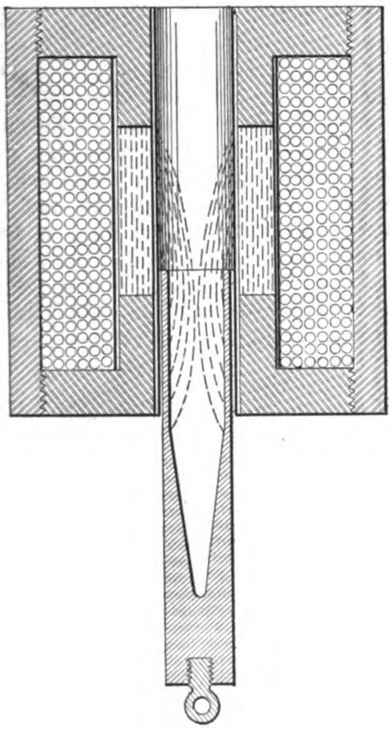


FIG. 4.—IRONCLAD SOLENOID.

It will be noticed that the plunger of this solenoid (Fig. 4) is hollowed out peculiarly. The upper end is tubular with parallel walls for a distance equal to the length of the air-gap between the two sections of the solenoid core. Below this the bore is tapered, until the plunger becomes a solid rod. The object of this arrangement is to make the pull more gradual and extend its range. If the plunger were a straight rod or a tube the pull would diminish very rapidly as soon as the air-gap was bridged by the plunger in its upward movement. With the construction shown, however, each increment of upward movement strengthens the flux and maintains the pull upon the plunger after the air-gap has been bridged. The disadvantage of this type is that it is utterly impracticable to predetermine the strength of the magnetic pull with any degree of accuracy, but it is a highly useful form of solenoid, and the only one yet devised which gives economically a powerful pull over a wide range.

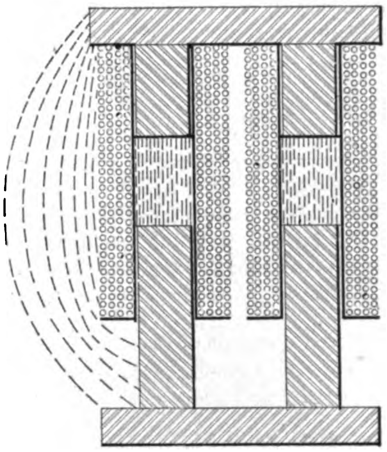


FIG. 5.—DOUBLE "STOPPED" SOLENOID.

A much more manageable design is that of the double "stopped" solenoid, shown by Fig. 5. In this case the tractive force of the magnetic lines is exerted in a straight line directly between the opposing faces of the stationary cores and the movable ones, and as the air-gap is enclosed by the magnetizing coils the amount of waste leakage is almost negligible. When the plungers or movable cores are down, as shown in the sketch, there is considerable leakage of lines of force around the outside of the coils, as indicated by the dotted lines on the left-hand side of the drawing. This leakage flux, however, is by no means wasted, as it joins with the flux which passes through the iron, and contributes to the pull in the air-gap. Moreover, although the exterior leakage renders the calculation of the power of the magnet inaccurate, if it is based simply on the law of magnetic traction, the inaccuracy is in favor of the magnet; that is to say, it will be more powerful than the calculation indicates. For all ordinary purposes, therefore, it will be sufficiently accurate to calculate the pull exerted by such a magnet by means of Maxwell's formula, which is the basis of the tables given.

In applying the fifth column of Table I or the fourth column of Table II to this construction the polar area should be taken as that of both of the cores. The length of the magnetic circuit, of course, will be taken as the total length of both cores plus the length of both yokes from center to center of the cores, for the iron part of the circuit; and the length of the two air-gaps for the air part of the circuit. This form of magnet, however, is inconvenient mechanically in that the armature or movable part of the core must be provided with a guide of considerable length in order that it may slide freely within the coils without binding; otherwise, if the bore of the coils is made to fit the cores snugly, as it should, the slightest tilting will cause the sliding cores to bind.

On this account the form illustrated by Fig. 6 is preferable. This form also possesses the advantage of being entirely ironclad, so that the coil is mechanically protected, and it is somewhat cheaper to construct because there is only one coil to be wound and all of the machine fitting is circular. This arrangement might be termed a "stopped" ironclad solenoid, and like Fig. 5, it is a combination of solenoid and magnet proper. It possesses the advantage of having no magnetic leakage whatever, and only a single air-gap; consequently, for the same range of movement the air-gap will be approximately one-half the length of the air-gap in the double-coil type shown in Fig. 5.

There is a small constant air-gap between the plunger and the iron disc through which it moves, but this can easily be reduced to 1/64 in., and constitutes an almost negligible part of the total air-gap. The pull exerted by this form of magnet can be predetermined with sufficient accuracy for practice by the application of the law of traction, and consequently by means of the accompanying tables. For operating mechanisms where a graduated pull is of not so much consequence as a good strong initial pull, and where the range of movement is reasonable, as in the case of a semaphore signal, for example, this type of magnet is

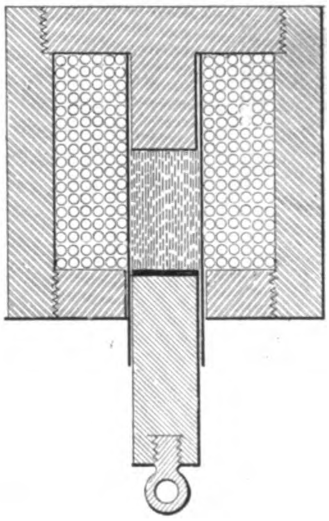


FIG. 6.—"STOPPED" SOLENOID.

probably the best of any of the existing forms.

When applying either this form or that of Fig. 5 to service in which the plunger is to be drawn solidly against the stationary core, the face of the plunger should be covered with a thin sheet of non-magnetic metal, such as brass or copper, so that when the circuit is broken the plunger will fall promptly. It might be well to call attention also to the fact that in the case of any magnet the power of which is considerable, and which is thrown into and out of circuit, the coil should contain in addition to the exciting winding a short-circuited winding for eliminating the inductive effect due to the sudden opening of the circuit. Where the magnet is constantly in circuit, however, and merely responds to variations in current strength, such an arrangement is usually not necessary.

Fan Motors for 1901.

The approach of warm weather brings the fan-motor industry to the fore again, and in accordance with the custom established by this paper four years ago, we publish herewith descriptions of the standard machines of this class that will be offered for the coming season. Not many changes are apparent since last spring, so far as essential features of construction are concerned; as stated last year, these little machines are practically standardized and their design has reached a point beyond which no radical improvement seems commercially practicable.

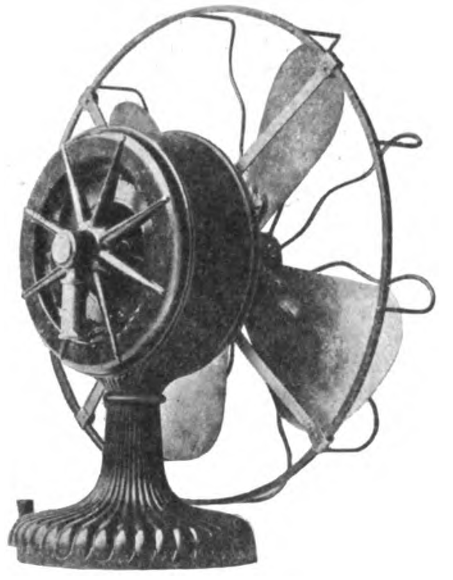


FIG. 1.—WESTINGHOUSE ALTERNATING-CURRENT FAN MOTORS.

The Westinghouse Company has retained the induction type of motor for alternating-current circuits which was built last year, only a few improvements applied to minor details having been practicable. The machine is illustrated by Fig. 1, and the rotor is shown by Fig. 2. The field magnet is of course laminated, the field ring being provided with inwardly projecting teeth to which the field winding is applied. The rotor is of the usual squirrel-cage type, the conductors being bare copper rods threaded through holes in the core without insulation. The bearings are self-oiling and self-aligning, and the oil chambers hold sufficient oil to run through an entire season. The fan is 13 ins. in diameter with four blades. A two-speed switch is provided in the base of the motor. The motors are built for either 60 or 133 cycles.

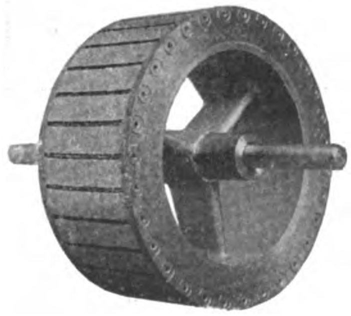


FIG. 2.—ROTOR OF WESTINGHOUSE ALTERNATING-CURRENT FAN MOTOR.

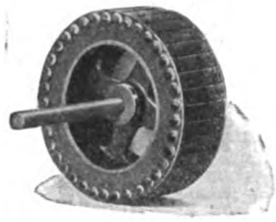


FIG. 3.—G. E. SQUIRREL CAGE ARMATURE.

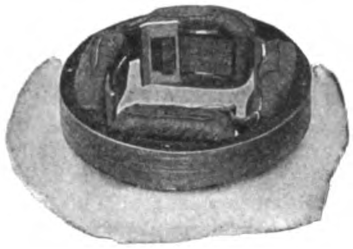


FIG. 4.—G. E. ALTERNATING-CURRENT FIELD.

The General Electric alternating-current desk fan motor, shown by Figs. 5-7, is also an induction machine with a squirrel-cage armature, and the rotor conductors, like those of the Westinghouse motor, are put in without any insulation whatever. The rotor is illustrated by Fig. 3, and Fig. 4 shows the field magnet used in this machine. The field structure is laminated, as usual, and provided with four physical poles, each pole carrying an exciting coil and a short-circuited shading coil, the function of the latter being to split the magnetic flux into two phases, and give the necessary starting torque.

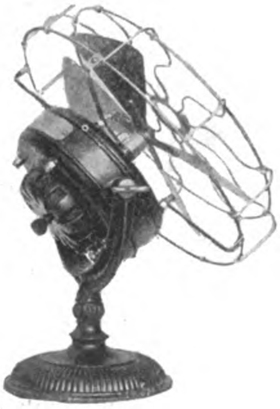


FIG. 5.—G. E. ALTERNATING-CURRENT DESK-FAN MOTOR; REGULATING COIL IN THE BACK OF THE CASE.

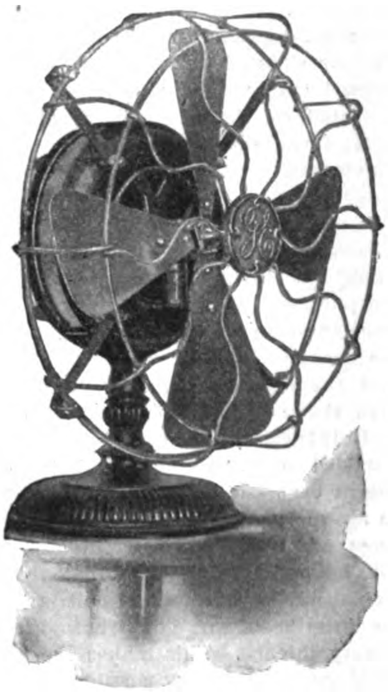


FIG. 6.—G. E. ALTERNATING-CURRENT FAN MOTOR.

The field magnet structure is usually built up complete, as shown in Fig. 4, before insertion in the casing of the motor. Speed regulation is obtained by means of a reactive coil mounted in the back of the motor casing, as shown in Fig. 5, which also illustrates the trunnion style of mounting. There are two running speeds, namely, 1150 and 1550 r.p.m. The 12-in. fans require 68 watts at full speed and 51 watts at slow speed. These machines are built for 60, 125 and 133 to 140 cycles, and for 52, 100 to 108, and 108 to 115 volts; special motors are also built on demand for 220 volts. Fig. 7 represents the bracket form of mounting, in which the reactive coil is contained in the base of the bracket.

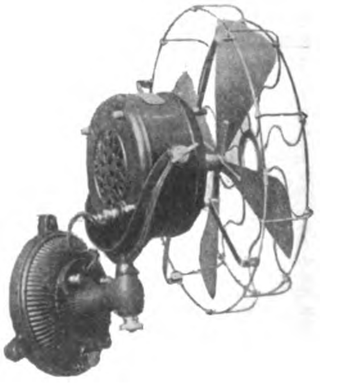


FIG. 7.—G. E. ALTERNATING BRACKET MOTOR; REGULATING COIL IN WALL BRACKET.

Fig. 8 represents a compensator which is provided whenever necessary for the purpose of using a motor built for one voltage on a circuit of different voltage. The compensator consists of an auto-transformer with two pairs of binding posts, one pair for 52 volts and the other pair for 104 volts. Its use obviously enables a 52-volt motor to operate on a 104-volt circuit, or a 104-volt motor to operate on a 52-volt circuit. When the fans are to be attached to thin partitions the flexible mounting shown by Fig. 10 is supplied. This consists merely of an ornamental bracket from which the motor is hung by springs in order that the humming of the machine may not be transmitted to the partition. The motor is provided with a 10-in. fan and a strap switch is mounted on the wall plate of the bracket.

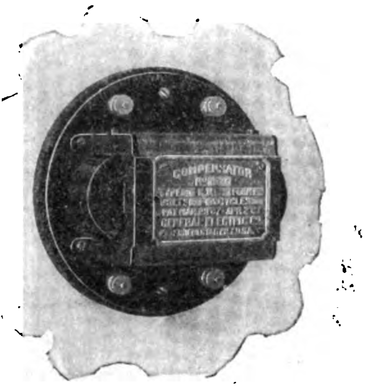


FIG. 8.—G. E. FAN MOTOR COMPENSATOR.

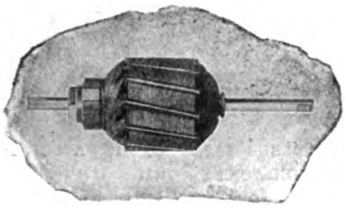


FIG. 9.—G. E. DIRECT-CURRENT ARMATURE.

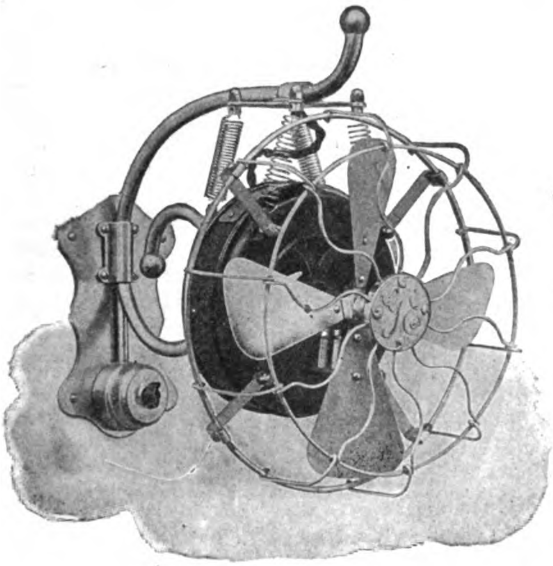


FIG. 10.—G. E. SUSPENSION FOR SMALL FAN MOTORS.

The field magnet of the General Electric direct-current fan motor is a laminated structure built up and having its coils mounted on the poles before insertion in the case of the machine, the same as in the alternating-current motor; Fig. 12 shows this construction. The armature, which is shown by Fig. 9, is of the ordinary drum-wound type with the core discs twisted so as to give a sort of spiral or diagonal direction to the slots, the object of which construction is to eliminate the humming due to the abrupt entrance and exit of the teeth into and from the magnetic field. The brushes are carbon pencils of rectangular cross-section and are fed to the commutator in the usual manner by brass spring-actuated pressure equalizing fingers. The general external appearance of the direct-current fan is shown by Fig. 11. The body of the fan is elliptical in outline and entirely enclosed, removable shields serving to shut in the commutator and brushes. These fans have three speeds, 900, 1200 and 1600 r.p.m., respectively. The power required at full speed by the 12-in. fan is 53 watts, at medium speed 38 watts, and at slow speed 30 watts. The motors are built for the usual direct-current voltages.

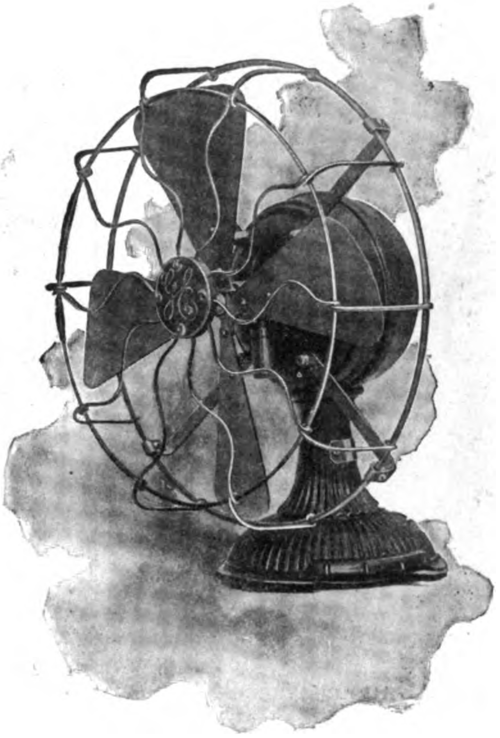


FIG. 11.—G. E. DIRECT-CURRENT FAN MOTOR.

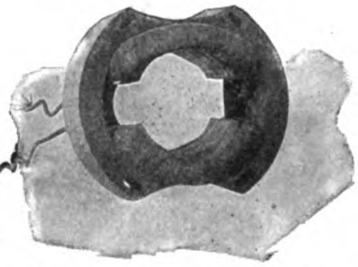


FIG. 12.—G. E. DIRECT-CURRENT FIELD MAGNET AND COILS.

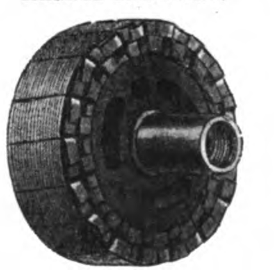


FIG. 13.—ARMATURE OF EMERSON DESK MOTOR.

Another efficient induction type of fan motor is that built by the Emerson Electric Manufacturing Company. Fig. 14 represents the standard Emerson model for 60-cycle circuits, and Figs. 13 and 15 show the construction of this machine. The field magnet has four poles, and each pole carries two windings, one of the ordinary form embracing the entire pole and the other a "shading" winding which is wound on only half of the pole, a slot in the center of the magnet pole piece being provided for this purpose. The function of the shading winding is the same as that of the short-circuited shading coils in the General Electric alternating-current fan motor previously described. The rotor is of the squirrel-cage type, but the conductors are flat copper strips instead of the usual round bars, this construction

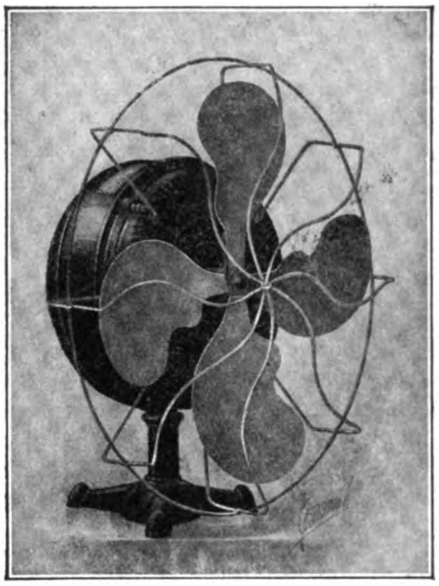


FIG. 14.—EMERSON DESK FAN MOTOR.

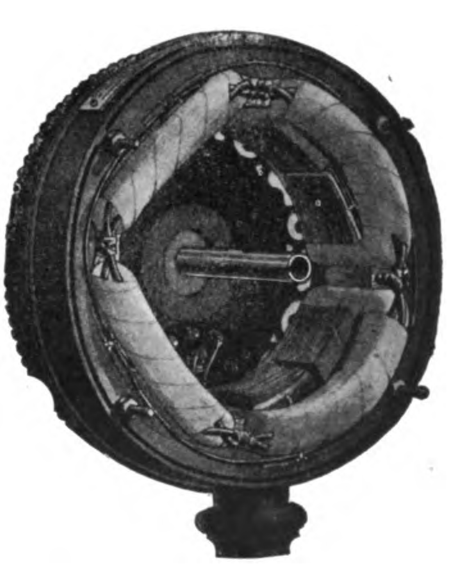


FIG. 15.—INTERIOR OF EMERSON DESK FAN MOTOR.

being necessary in order to obtain the requisite number of conductors and at the same time give the rotor core sufficient cross-section without making its diameter abnormally large. This type of fan is built for either 60 or 133 cycles. In the 133-cycle motors the armature conductors are round rods instead of the type shown in Fig. 13.

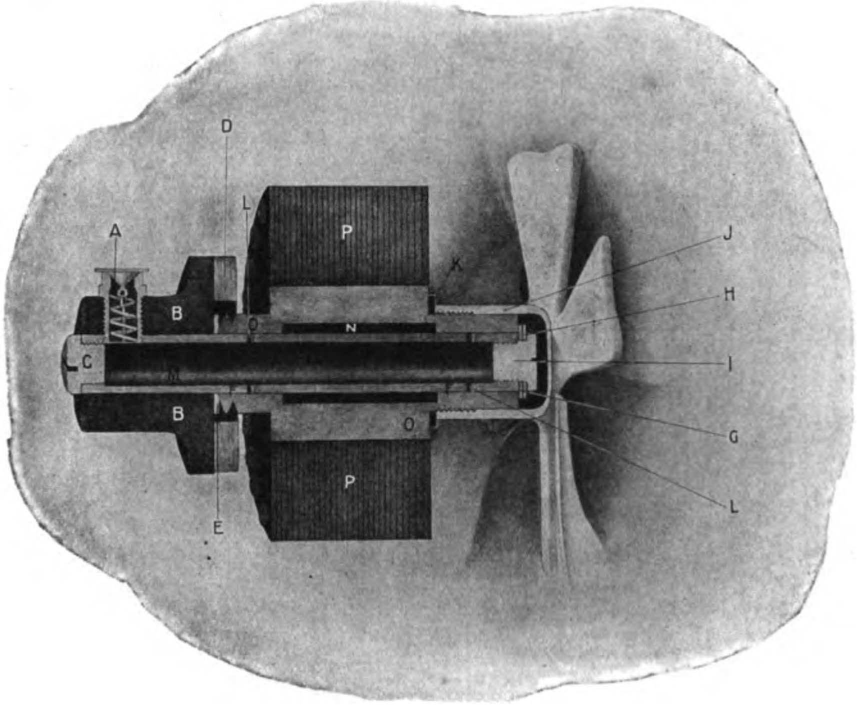


FIG. 16—SECTION OF EMERSON DESK FAN ARMATURE.

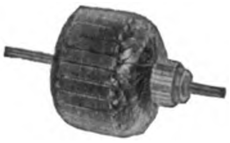


FIG. 17.—ARMATURE OF LUNDELL ALTERNATING-CURRENT MOTOR.

Fig. 20 illustrates the Emerson "Special" model fan motor in bracket form, which is new this year. Its mechanical construction is identical with that of the standard model. The rotor conductors, however, consist of round copper rods like those in the rotor of the 133-cycle standard model. The type of field winding employed is new, however, and is said to give the machine a higher degree of efficiency than that previously obtained. Fig. 16 shows a cross-section of the armature and bearing of the special model for 60 cyles. The armature spindle, M, is hollow and stationary, being permanently secured to the hub, B, which forms a part of the back cover of the machine. The armature core, P, is mounted on a central hub, O, which revolves about the stationary shaft, M. Oil is supplied to the hollow spindle through the cup or well, A, and delivered to the bearing surfaces through the oil holes, L. In addition to the oil, a supply of lubricant is provided in the chamber, N, between the two bearings, which is sufficient to last throughout the season. The throwing of oil is prevented by the felt washer, D, at one end, and the cap, J, which constitutes the hub of the fan at the other end. The hollow spindle is closed by the plugs, C and I. The bearing for the standard model is precisely like that just described, except as to the manner of applying the fan hub. In the standard model the fan hub screws into the armature hub instead of on the outside of it. The 12-in. special fan motor requires something less than 55 watts at full speed and gives a stronger breeze than the motor previously built, which used 65 watts. The weight of the machine has also been reduced, its net weight being 17 lbs. The power factor of the new motor is very high, the machine driving a 12-in. fan at 104 volts requiring less than ¾ ampere. The special model fans are built for 60-cycle circuits only.

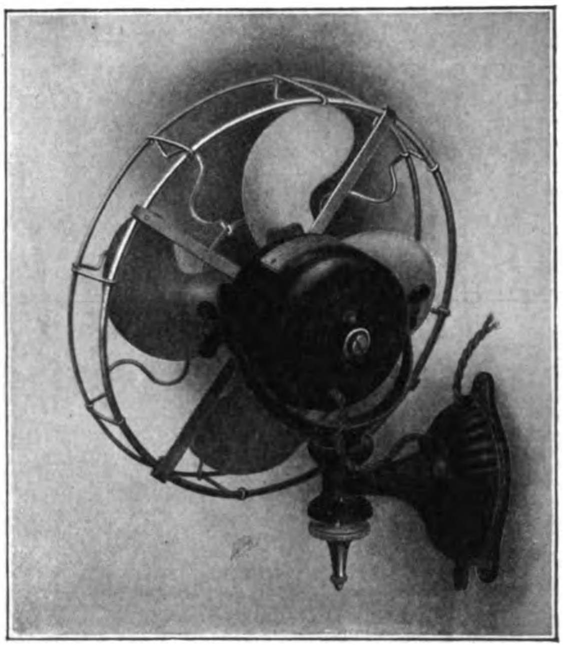


FIG. 20.—EMERSON "SPECIAL" MODEL FAN MOTOR, BRACKET FORM.

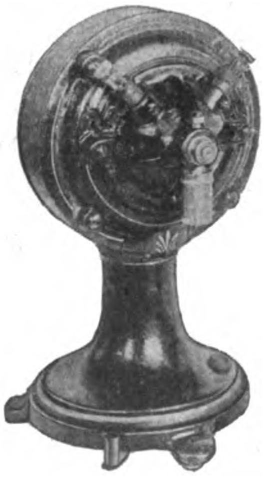


FIG. 18.—LUNDELL ALTERNATING-CURRENT DESK FAN MOTOR.

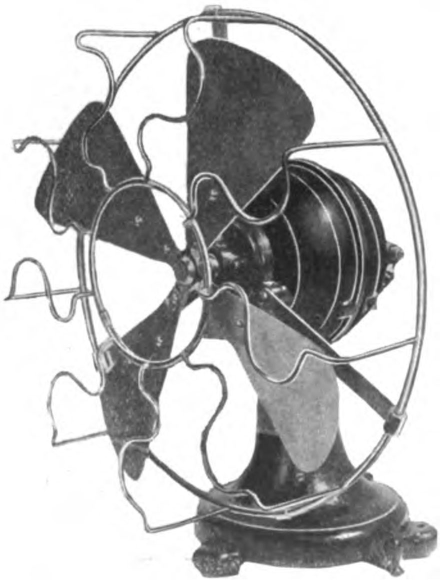


FIG. 19.—LUNDELL DIRECT-CURRENT FAN MOTOR.

The Lundell alternating-current desk fan, built by the Sprague Electric Company, is shown by Fig. 18. It has an eight-pole field and a composite-wound armature, one winding consisting of eight coils close-circuited on themselves, and the other of an ordinary drum winding connected to a commutator. The field magnet is an ordinary simple winding of eight coils connected in series with the commutator brushes. The motor starts up as an ordinary series-wound machine, and as it approaches synchronism the short-circuited armature windings convert it into a single-phase induction motor. The impetus given to the armature by this winding carries it up to synchronous speed, at

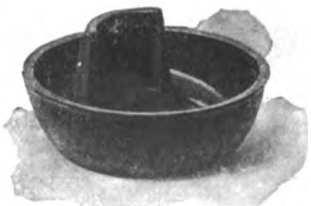


FIG. 21.—LUNDELL FIELD-MAGNET FORGING.

which point the current in the drum winding is rectified, turning the armature core into a revolving field magnet excited by a pulsated direct current. The relation between the revolving and stationary members then becomes that of a synchronous motor. The stationary member, which was originally the field magnet, being energized by alternating current, now fulfills the function of a synchronous motor armature, while the revolving part constitutes the field magnet. Fig. 17 illustrates the armature of the machine.

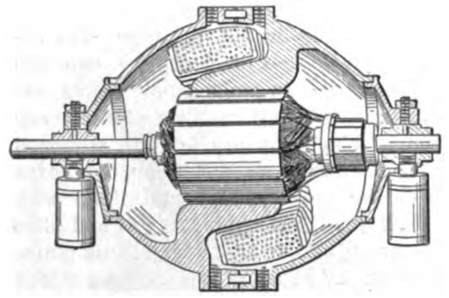


FIG. 22.—SECTION OF LUNDELL DIRECT-CURRENT MOTOR.

The Lundell direct-current fan motor, illustrated by Fig. 19, is of the familiar concentric field-coil type characteristic of the well-known Lundell power motors. A cross-section of the machine is shown by Fig. 22, from which it will be clear that the field coil, while concentric with the armature, is tilted, so that its transverse plane is not parallel with that of the armature. The object of the tilting will be evident from an inspection of the engraving. The field magnet is made in two halves, each half being drop-forged to the shape shown by Fig. 21. The two halves when assembled form the complete field magnet, and are held in alignment by a circular feather, shown at the top and bottom of the structure in Fig. 22. The field magnet is held together axially by a circular plate and two screws fitted to a boss on the top of the shell and a similar arrangement at the bottom. The construction of the magnet allows the armature to be inserted and withdrawn without dismantling the main structure at all. It is only necessary for this purpose to remove one of the end caps which carry the bearings. The oiling arrangement is of the wick type invented by Mr. Lundell. A slight change has been made in the arrangement of the wick so that it will feed the last drop of oil in the cup.

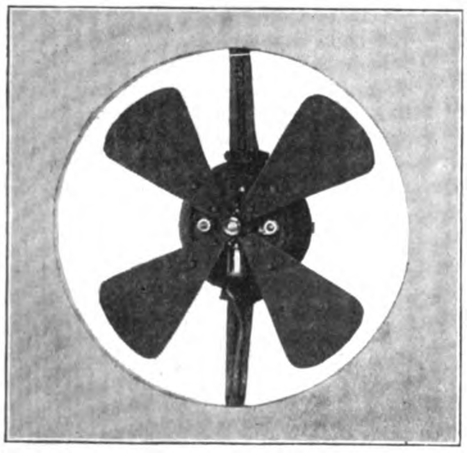


FIG. 23.—LUNDELL MOTOR FOR VENTILATING SERVICE.

In the base of the motor is the regulating rheostat, which gives the motor three speeds. At the maximum speed a 12-in. fan requires .45 ampere at 115 volts. The brush-holders and brushes are of the plunger type, comprising carbon pencils housed in metal cylinders and pressed against the commutator by small coiled springs. The metal cylinders are mounted in insulating bushings located in lugs on the end cap. Fig. 23 shows a Lundell motor adapted for ventilating service. The machine illustrated is an ordinary fan motor mounted in an opening on two brackets. The opening in which the fan blade revolves is cut in a board which is of such size as to fit in an ordinary window casement, rendering any special fitting unnecessary.

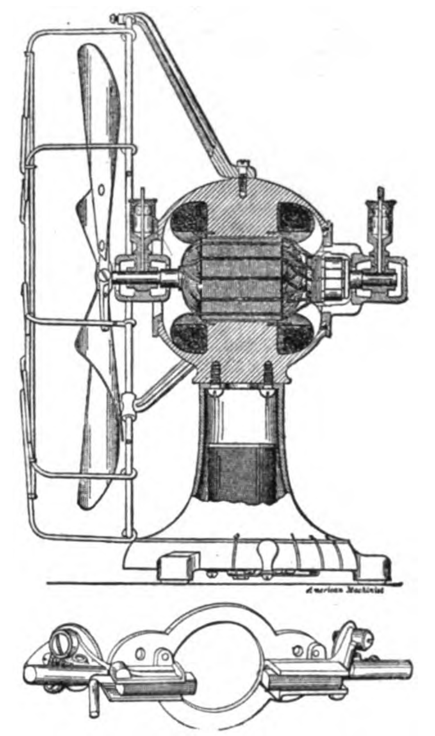


FIG. 24.—SECTION OF HURRICANE MOTOR AND THE BRUSH HOLDERS.

Fig. 25 illustrates the Hurricane direct-current desk fan motor, which, like the Lundell machine, has a spherical contour. The internal construction, however, is very different, as the cross-sectional view given by Fig. 24 will show. The field magnet is cast in a single piece; it is bipolar and has circular openings diametrically opposite each other, through which the field coils and the armature may be inserted and removed. Fig. 24 shows the brush-holder arrangement; flat carbon brushes are used and these slide in slots in the metal portion of the brush-holders. The brush-holders proper are screwed to a piece of fiber which has the shape of a discoidal ring with diametrically-opposite wings. The hole through the center of the fiber ring is just large enough to permit the commutator to project through. The brushes are pressed toward the commutator by coil springs and plungers in tubular housings, the plungers having pins projecting at right angles which impinge against the rear ends of the brushes. The object in using this arrangement instead of allowing the ends of the plungers to press directly against the ends of the brushes is to enable one to withdraw the pressure of the springs from the brushes and leave the brushes free for removal without removing the tubes containing the plungers and springs.

Though the brush-holders are screwed to the wings of the fiber piece above mentioned, they are not mechanically supported by it when in position on the motor but are bolted to the frame of the motor and serve to support the fiber plate between them. The opening in that side of the motor frame toward the commutator is not strictly circular, but has an outline corresponding precisely with the outline of the fiber piece attached to the brush-holders. This is necessary in order to permit the insertion of the field coils; slots on each side of the circular aperture being provided for this purpose.

The cross-sectional view, while illustrating the motor construction, does not illustrate the adjustable feature of the base. Referring again to Fig. 25, a short lever will be seen projecting at right angles to the pedestal. By raising this lever a ball and socket joint at the top of the pedestal is loosened, allowing the adjustment of the motor in a horizontal plane to any angle within a range of 180°, and the tipping of the motor upward or downward to any angle within a range of 30°. Pressing the lever downward tightens the ball and socket joint. Goldmark & Wallace are the general agents.

The Holtzer-Cabot desk fan, Fig. 26, belongs in the same constructional class as the Hurricane machine. The field magnet is spherical, except for the flattened surfaces where the end caps are fastened on, and is a single casting of soft steel. The magnet is bipolar, as the illustration

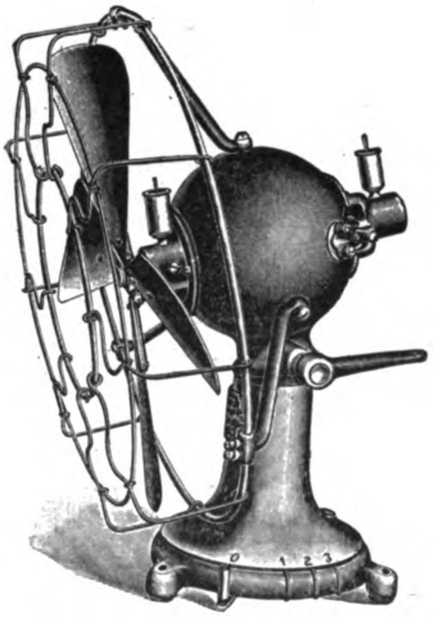


FIG. 25.—HURRICANE DIRECT-CURRENT DESK FAN MOTOR.

plainly shows, and the field coils are inserted through the round openings and held in place by a brass ring which presses against both the upper and lower coils and prevents their accidental displacement. The armature is of the usual construction, having a laminated core and drum winding. The end caps are simple discs of iron in which are cast the grease cups, so that no separate parts are required and there are consequently no joints to render leakage possible. The journal caps can be rotated into any one of four positions so as to bring the grease cup above the bearing, no matter whether the motor be used on a desk, screwed to a wall, or mounted on a ceiling. The bearings proper are of phosphor bronze, self-aligning.

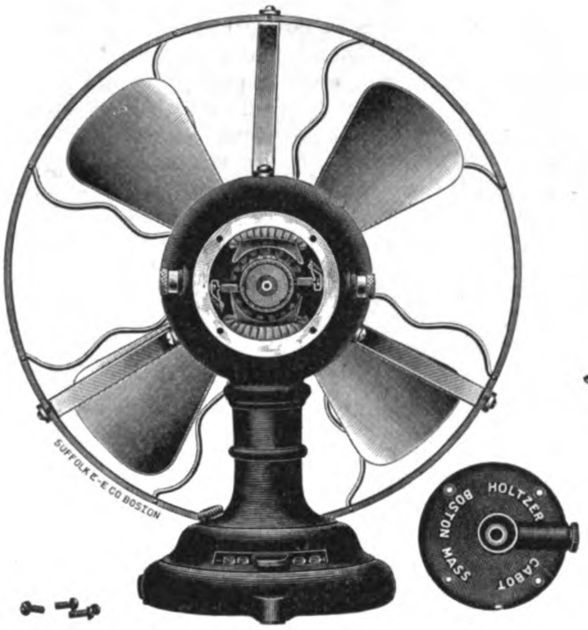


FIG. 26.—HOLZER-CABOT DESK FAN.

The brush-holders are unusually efficient without being at all complicated. Fig. 27 shows a brush and brush-holder full size and the construction will be obvious at a glance. The tension of the spring gives practically uniform pressure throughout the life of the brush; the slot through which the tension finger moves is closed at the front end of the brush-holder so that the finger cannot come in contact with the commutator in case the machine should be used without attention until the brush is worn down sufficiently to drop out. The brush-holder may be readily removed from the case by merely loosening the nut and turning the button (which holds the brush-holder to the end of the insulating plug) at right angles to its normal position. A four-speed rheostat is mounted in the base and the connecting cord is fastened to terminals on the inside of the base, so that there is no danger of their becoming short-circuited or of the user receiving a shock. Fig. 28 shows a Holtzer-Cabot fan with a special mounting for suspension from the ceiling. This machine is provided with a worm adjustment for tilting it to any desired angle.

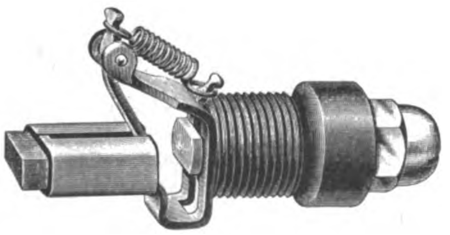


FIG. 27.—HOLZER-CABOT BRUSH HOLDER.

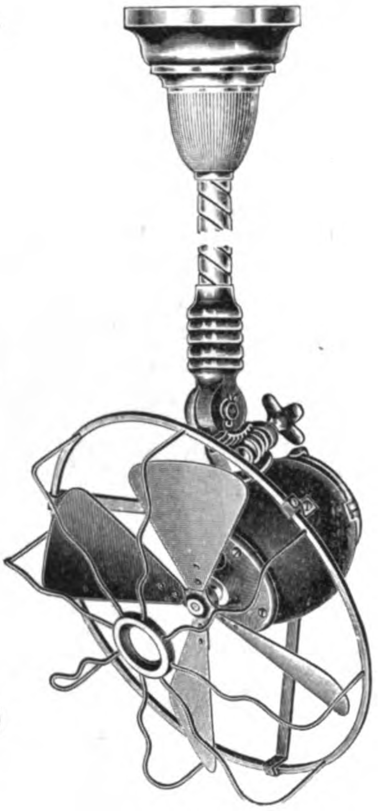


FIG. 28.—HOLZER-CABOT CEILING SUSPENSION FAN.

The Western Electric Company has retained the horseshoe form of field magnet which has characterized its desk fans for the past few years and has given excellent results in practice. Fig. 29 is a view of the 12-in. desk fan, and Fig. 30 is a cross-section of the machine. The field magnet is of wrought-iron drop forged, and is secured to the pedestal by means of the single bolt, E. The armature is of the usual drum-wound construction, the wires being wound in slots. The armature is entirely enclosed by two end caps bolted to the magnet pole-pieces, except for two small openings in one cap through which the brushes are admitted to the commutator. The journal boxes are of the self-aligning type, lined with the best quality of babbitt metal and oiled by means of wicks, as the engraving plainly shows. A detail of the bearing which is of considerable importance is the arrangement of the tube through which the lubricating wick passes up to the shaft. This tube screws into the under side of the journal sleeve, so that the wick does not come in contact with the seat of the sleeve and oil cannot leak out at that point. The wick tube also serves to keep the sleeve in position both angularly and laterally, while allowing it to align itself with perfect freedom. The brushes are of specially-prepared graphite fed to the commutator by means of coiled springs.

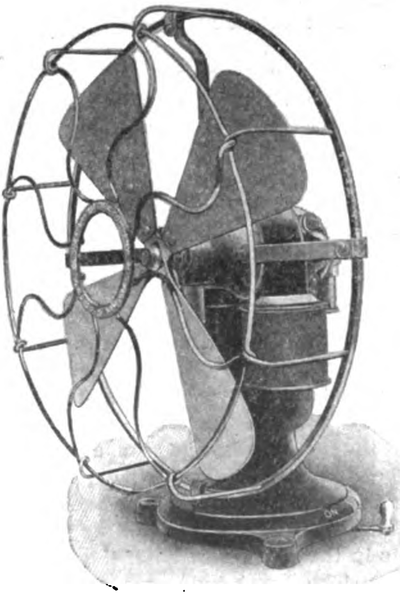


FIG. 29.—WESTERN ELECTRIC DESK FAN.

A three-speed rheostat is put in the pedestal with the switch handle projecting beyond the base. The rheostat consists of German silver wire wound upon a porcelain spool, insulated with asbestos and mica, and mounted on a porcelain base. These machines are wound for the usual direct-current voltages, and the 220-volt and 500-volt motors are designed to be

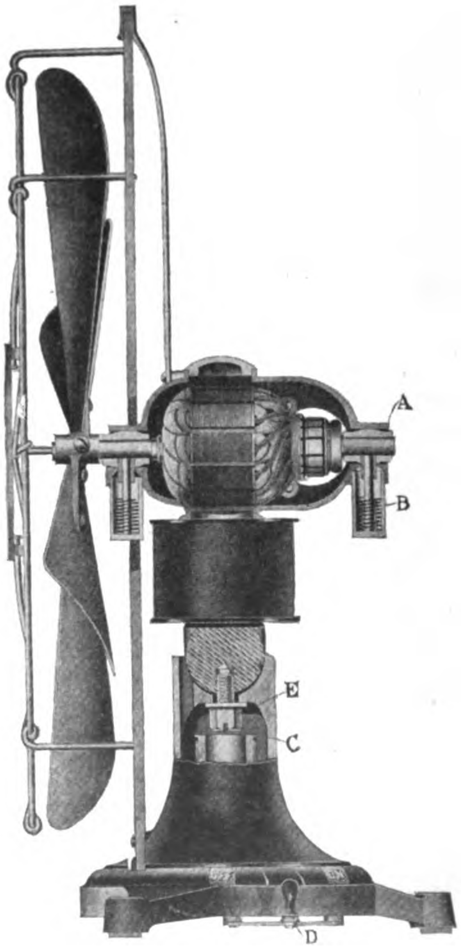


FIG. 30.—CROSS SECTION OF WESTERN ELECTRIC DESK FAN.

connected directly to the service wires without the use of any dead resistance to cut down the voltage. The 500-volt machines, in addition to the regulating switch, are provided with a double-pole quick-break switch. The current consumption of these machines at full speed is 0.36 ampere at 110 volts, 0.2 ampere at 220 volts, and 0.11 ampere at 500 volts. The speed is 1800 r.p.m., with the exception of the 110-volt motor, which runs at 1875 r.p.m.

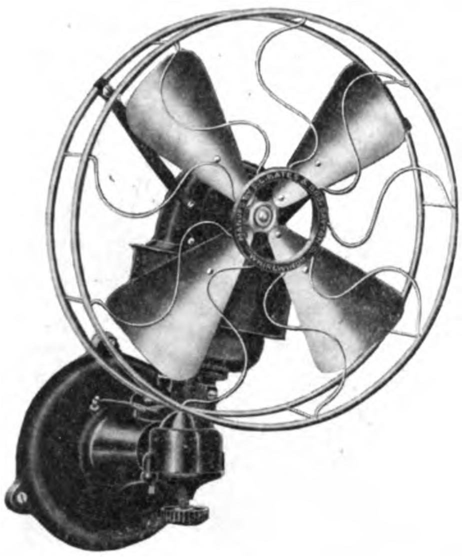


FIG. 31.—BATES DIRECT-CURRENT DESK FAN.

The Bates direct-current desk fan, illustrated by Fig. 31 is similar in general construction with the fan motor just described, the field magnet being of the bipolar inverted horseshoe type, provided with end caps screwed to the pole-pieces so as to enclose and protect the armature and commutator. The magnet core is forged steel. The engraving shows the bracket form of motor with universal adjustment, but the machine is, of course, built also in the usual pedestal form for desk service. The current consumption of the 12-in. 110-volt fan is 31 watts, and the maximum speed is 1900 r.p.m. The 16-in. size requires 60 watts and runs at 1600 r.p.m.

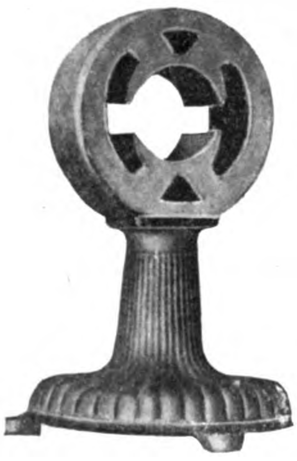


FIG. 32.—"ECLIPSE" FIELD MAGNET.

Still another fan motor having a bipolar horse-shoe field magnet is the Peerless, illustrated by Fig. 34, and built by the Warren Electric & Specialty Company. The field magnet is a steel drop-forging of high magnetic permeability; the field coils are wound on fiber spools, protected by a heavy layer of insulating material and enclosed in brass jackets. The armature of this motor is wound with double silk-covered wire, and the commutator segments are cut from hard-drawn copper bar. The bearings are of the usual self-aligning type made from a high grade of gun metal, and lubricated by means of a wick oil cup of the usual form. The brushes are of the carbon pencil plunger type mounted in brass tubes. The Warren Company also builds a fan motor of the enclosed field type in two forms, one of which is illustrated by Fig. 36. The machine illustrated is not adjustable on the pedestal, and runs at only one speed. The 12-in. 110-volt fan runs at 1650 r.p.m., and requires ½ ampere. This fan is known as Type G. The same type of field magnet is used in an adjustable fan known as Type E, in which form the motor is mounted on trunnions, for vertical adjustment, and has also a horizontal swivel adjustment. The Type E fan moreover has a rheostat and switch in the base, which give it three running speeds, while the Type G machine has no speed adjustment.

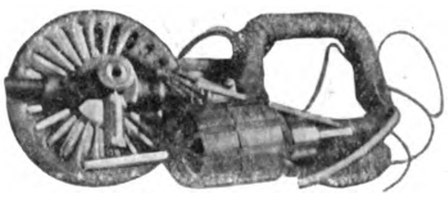


FIG. 33.—PARTS OF "ECLIPSE" MOTOR.

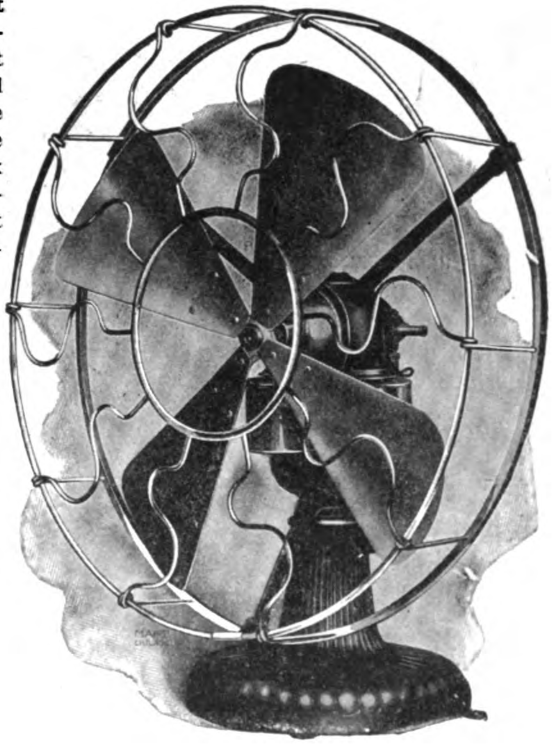


FIG. 34.—PEERLESS DESK FAN MOTOR.

An attractive form of enclosed motor, known as the "Eclipse," has been brought out this year by the Geo. C. Towle Manufacturing Company. Fig. 35 represents this fan with trunnion adjustment, and Fig. 32 illustrates the field magnet construction of the same motor but mounted solidly on the pedestal. The other parts of the machine are shown in Fig. 33. The illustrations show the electrical and magnetic features of construction so clearly as to render a description unnecessary. The machine has self-oiling and self-aligning bearings with wick feed, and is provided with a rheostat which gives it three running speeds, namely, 1000, 1600 and 2000 r.p.m. These motors are built for 110, 170, 220 and 250 volts, and are made in both the pedestal and bracket forms. The motor may be entirely dismantled by removing two bolts which hold both of the end caps in position.

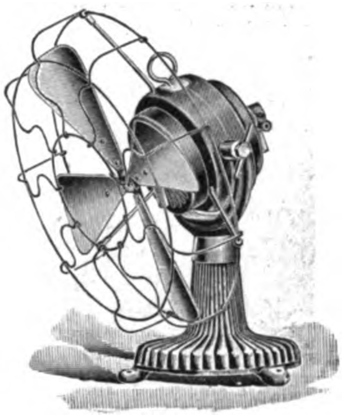


FIG. 35.—"ECLIPSE" DESK FAN MOTOR.

The Paragon desk fan motor for direct-current circuits is illustrated by Fig. 37. The characteristic Paragon form of field magnet has been retained, but the general appearance has been made more graceful by a slight change in the outline. It is of the bipolar type cast in a single piece. The armature and commutator are as-

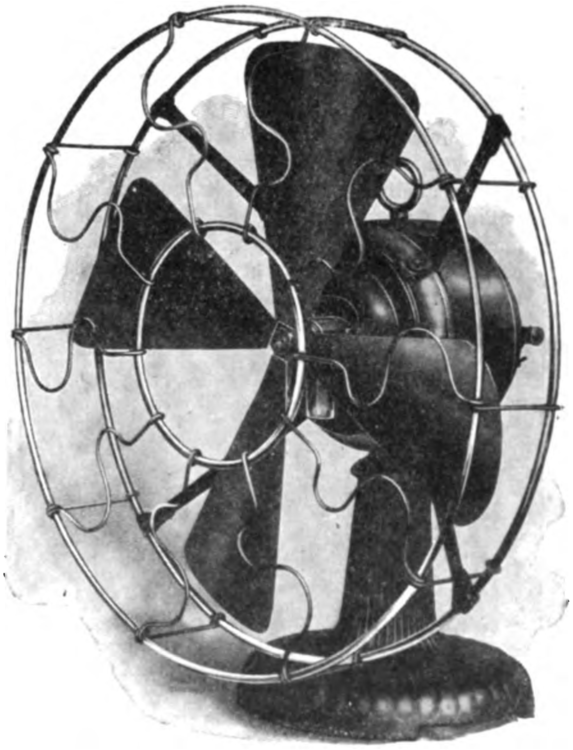


FIG. 36.—PEERLESS ENCLOSED-FIELD FAN MOTOR.

sembled under high pressure on brass tubes, which are headed over at each end, riveting the parts permanently in position. The brushes are of the pencil plunger type, but are made of rectangular cross-section so that they cannot turn in the holders and thus alter the area of the commutator contact. The brushes are mounted in insulating plugs in one of the end caps. The bearings are self-aligning, and of the wick-feed type. The wick is mounted, however, in a slightly different manner from that usually employed, being provided with a retaining tube which prevents it from buckling and insures its being always pressed firmly against the shaft by its spring. Fig. 38 illustrates the bracket form of mounting, which is of the searchlight trunnion type. The pedestal fans are also provided with this style of mounting when desired. The fans take 35 watts at 110 volts and 44 watts at 220 volts.

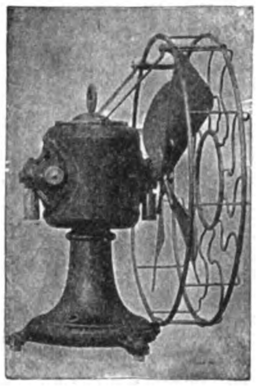


FIG. 37.—PARAGON DESK FAN MOTOR.

The Diehl direct-current desk fan motor is illustrated by Fig. 40; it will be noticed that the Paragon desk motor previously described is very similar to this one in external appearance. The chief difference in construction lies in the method of providing access to the interior of the field magnet case. Instead of using end caps of the ordinary type, the field magnet shell is divided vertically just beyond the magnet poles, and the smaller portion of the shell takes the place of the ordinary end cap. The brush-holders are mounted in this part of the machine, and the rear bearing is made integral with the field magnet shell, there being no opening at the back end, except the hole in the journal for the reception of the shaft. The field magnet is bipolar and the coils are, of course, form wound. The armature is wound with double silk-covered wire. The bearings have self-aligning bronze sleeves and self-feeding wick oil cups. The illustration shows a universal joint between the pedestal and the motor, which provides for adjustment of the air current. This machine is also built in bracket form.

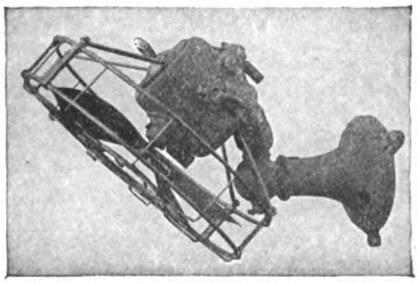


FIG. 38.—BRACKET MOUNTING OF PARAGON MOTOR.

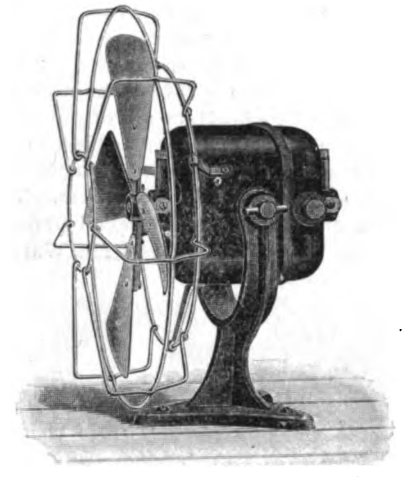


FIG. 39.—TRUNNION MOUNTING OF A DIEHL DIRECT-CURRENT MOTOR.

A later type of Diehl motor is shown by Fig. 39. In this machine the field magnet shell is split at the side distant from the fan, and the commutator and brushes are located at that side of the machine. The engraving shows the trunnion or searchlight mounting, but the machine is supplied with either ball and socket joint or a rigid pedestal. The trunnion mounting has the advantage that one machine may be used either for desk service or as a bracket motor; turning the fork through an angle of 90° serves to convert it into a bracket machine. In this type of motor also the oil cups are placed on top of the bearing, instead of beneath it, as in the type shown by Fig. 40.

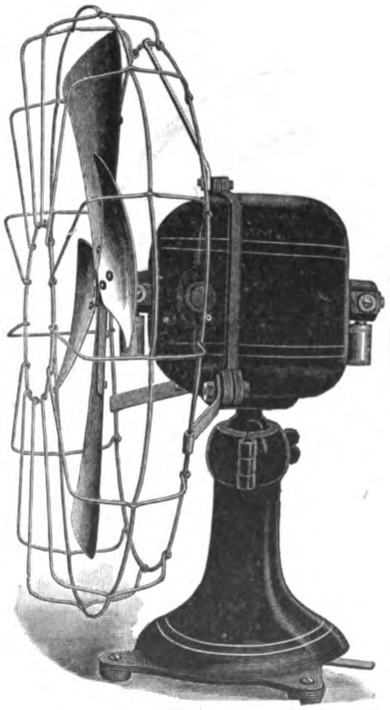


FIG. 40.—DIEHL DIRECT-CURRENT FAN MOTOR.

Fig. 42 illustrates the Falcon desk fan motor for direct-current circuits. This motor is of the familiar enclosed bipolar type with a ball and socket universal joint between the motor and the pedestal. The pedestal is provided with screw holes so that the machine may be converted into a bracket motor by simply turning the pedestal up at right angles with the vertical plane of the motor, and screwing the base to the wall. The motor case entirely encloses the armature, except for a small opening in each of the end caps. The case is split horizontally and held together with screws, the heads of which are sunk in slots in the side of the case. The armature may be removed, however, by taking off one of the end caps. The brushes are of the self-feeding carbon-pencil type, and the bearings are self-oiling with wick feed. The speed-regulating rheostat in the pedestal gives the machine three running speeds. The 12-in. fan requires 0.45 ampere at 115 volts, and 0.25 ampere at 220 volts. Three sizes of this fan motor are built, namely, 12-in., 15-in. and 18-in. fans.

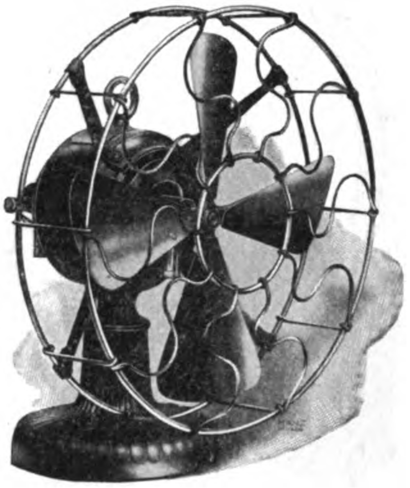


FIG. 41.—COLONIAL DIRECT-CURRENT FAN MOTOR.

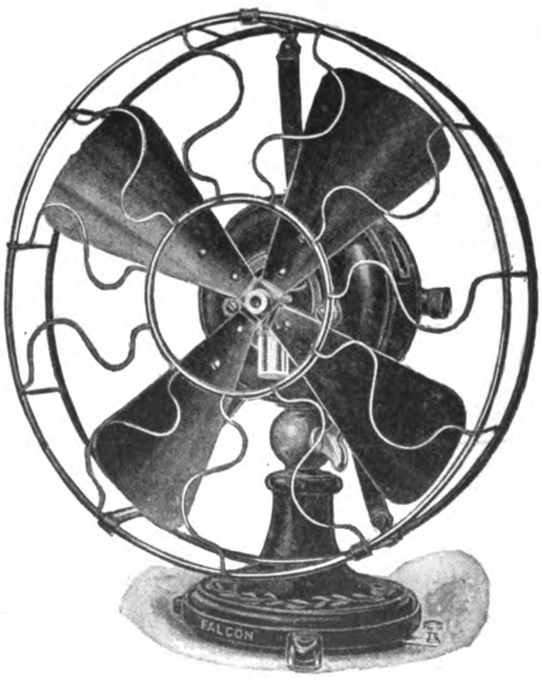


FIG. 42.—FALCON DESK FAN MOTOR.

The Colonial direct-current desk fan (J. Jones & Son), shown by Fig. 41, is of somewhat similar design, but the field magnet shell is cast in a single piece, the end cap being made large enough to permit the insertion and removal of the field coils, as well as the armature. It is a bipolar machine with the familiar form of carbon-pencil brushes and wick-oiling bearings. The bearings are of composition brass and self-aligning. The removal of two screws is sufficient to take the fan apart and give free access to the interior of the field magnet. This machine is also built in bracket form and is wound for 110-volt and 220-volt circuits.

Fig. 48 illustrates the Dayton Standard ceiling fan for direct-current circuits, and Fig. 45 is a cross-section of the motor which is a bipolar machine with peculiarly-constructed pole-pieces. The armature is a Gramme ring, supported from one side only, so that the pole-pieces may embrace three sides of the armature core. This arrangement obviously reduces the magnetic reluctance in the air-gap to an extremely low figure, and makes the field in which the armature rotates a very powerful one. The magnet coil is divided into two sections, this arrangement being necessary on account of the passage of the spindle through the center of the magnet. The armature is mounted directly on the ornamental cup which forms the lower part of the motor casing, and has a single bearing of the revolving shell type. The portion of the case marked B serves as an oil reservoir, and the cup, H, in the fan-blade hub catches the lubricant, and prevents its being thrown out by the blades.

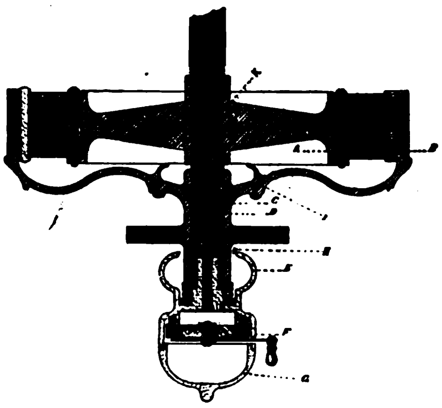


FIG. 43.—SECTION OF DAYTON ALTERNATING-CURRENT FAN MOTOR.

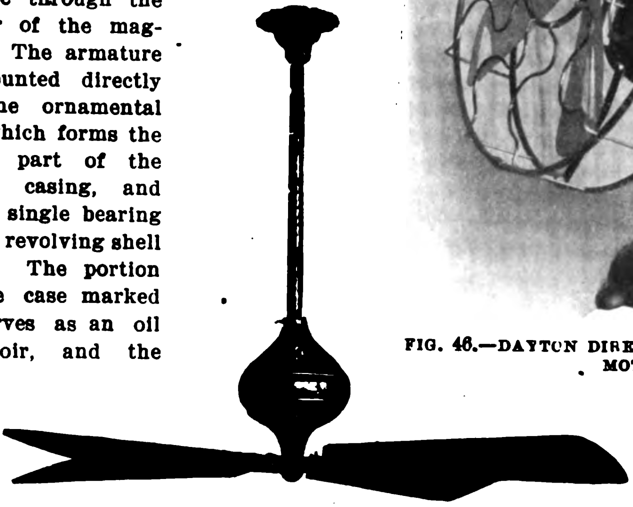


FIG. 44.—DAYTON, "JUNIOR" CEILING FAN MOTOR.

The Dayton Junior ceiling fan is illustrated by Fig. 44, and a cross-section of this machine is shown by Fig. 47. The field magnet is of the ordinary bipolar type and the armature is drum wound in slots. In this machine the armature shaft rotates within its bearing in the usual manner, and the lower part of the casing, B, serves as an oil reservoir, from which oil is fed to the lower end of the shaft and caught by the cup in the fan-blade hub. The upper end of the shaft is lubricated from the oil chamber, J, the drip from the bearing being caught by the cup, I, mounted on the armature shaft. The brushes are of the carbon-pencil or cartridge type, and the holders are mounted in the upper casing, as the engraving plainly shows.

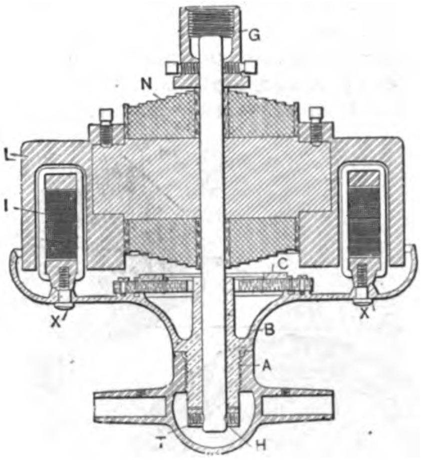


FIG. 45.—DAYTON CEILING FAN MOTOR.

The Dayton alternating-current fan, a cross-section of which is shown by Fig. 43, is a very simple machine. It has an internal field magnet or stator, A, into the center of which is fitted the stationary spindle, D. The rotor, B, is mounted on the lower casing, J, and this is provided with a bearing somewhat similar to that of the standard Dayton machine. It is also equipped with a ball bearing to take the downward thrust due to the weight of the revolving part. Fig. 46 illustrates the Dayton direct-current desk motor, which is similar in construction to the Junior ceiling fan motor, the only difference being that the machine is made shorter along the shaft, and the bearings are of the usual type employed in desk machines. The motor is provided with a trunnion or searchlight mounting, and is supplied for 110-volt, 220-volt or 250-volt circuits. The 12-in. machine consumes 44 watts on a 110-volt circuit.

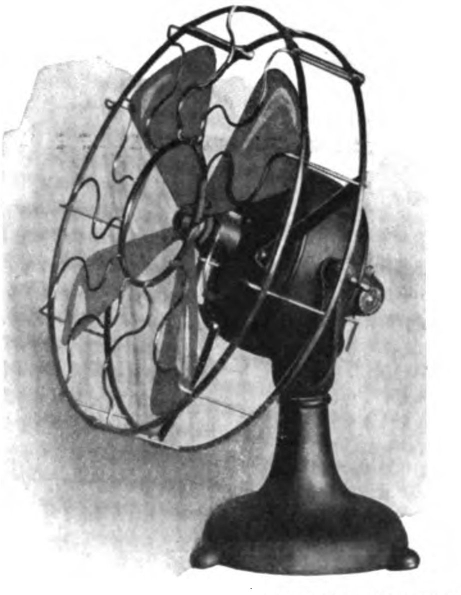


FIG. 46.—DAYTON DIRECT-CURRENT DESK FAN MOTOR.

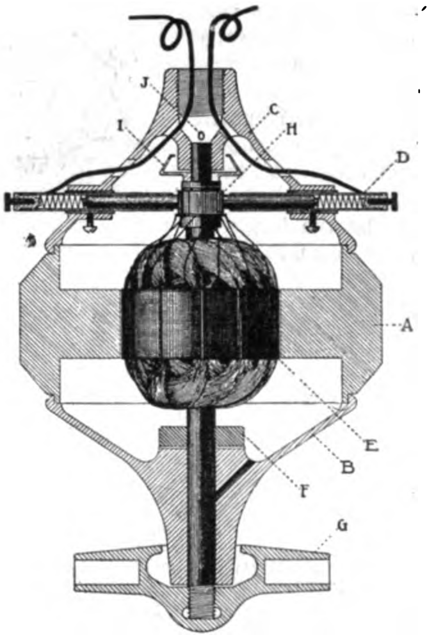


FIG. 47.—DAYTON, "JUNIOR" CEILING FAN MOTOR.

A cross-sectional view of the Western Electric Standard ceiling fan for direct-current circuits is given by Fig. 49. The motor is a bipolar machine, and the cross-section shown is taken at right angles to the vertical plane of the magnet poles. The armature is drum wound in slots, with the commutator located below it. The bearings are of a somewhat unusual type for a ceiling machine. The upper bearing is oiled by means of a wick from the side in the same way as the bearing of a horizontal motor, a cup or pan on the shaft serving to prevent the leakage of oil onto the armature. Immediately above this oil pan there is a small hole through the side of the shaft, which is hollow. The oil passes, therefore, from the upper bearing through the shaft to the lower bearing, H, and after lubricating this bearing it is caught by the cup formed in the upper part of the fan-blade hub, L. A heavy oil is used for lubricating the motor in

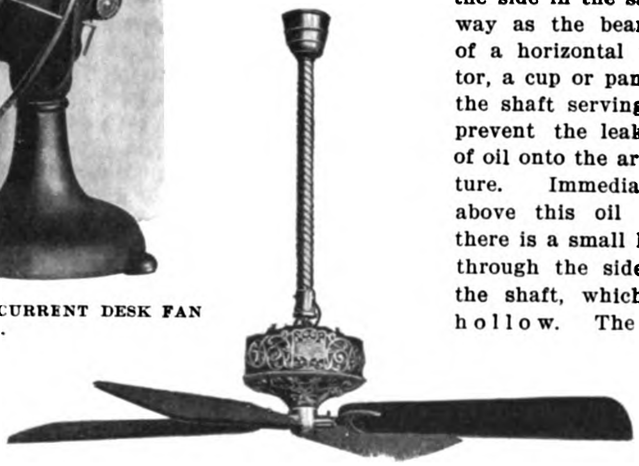


FIG. 48.- DAYTON DIRECT-CURRENT CEILING FAN MOTOR.

order to prevent it from running through too rapidly.

The armature shaft bearings are fastened directly to the magnet structure, so that any magnetic pull on the armature is transmitted directly to the magnet frame. This arrangement enables the air-gap to be made extremely small, as there is no liability to lateral displacement of the armature. The upper bearing is independent of the casing, so that the motor may be set up and handled conveniently with the stem and cover removed. The rheostat is mounted within the magnet structure, as indicated in the engraving by the letter D. The regulating switch, R, is at the extreme lower end of the fan shaft, and is made unusually substantial in order to avoid liability to damage by resting the fan upon the thumb-piece in handling it preparatory to installation. These fans are made for 110, 170, 220 and 500 volts. Fig. 51 is an exterior view of the Western Electric "Arctic" ceiling fan motor, which differs from the standard machine in that no switch or regulating rheostat is incorporated in its structure. As the illustration plainly indicates, the fan is controlled by a separate switch either hung from the ceiling or mounted on a nearby wall. The Arctic fan is wound for the same voltage as the standard motor.

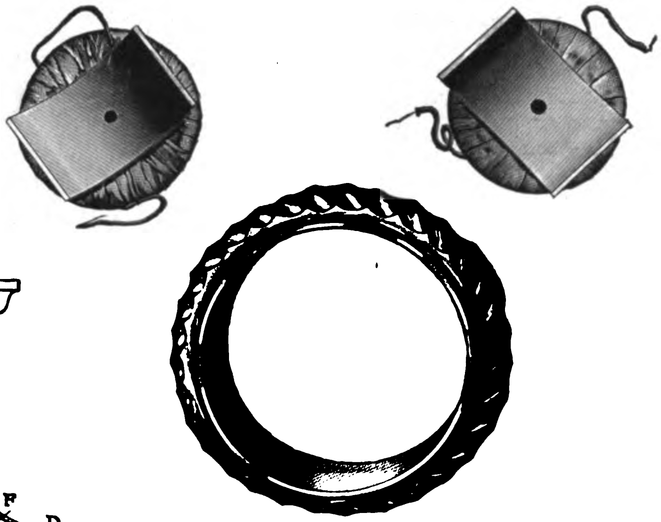


FIG. 50.—PARTS OF ROBBINS & MYERS STYLE A MOTOR.

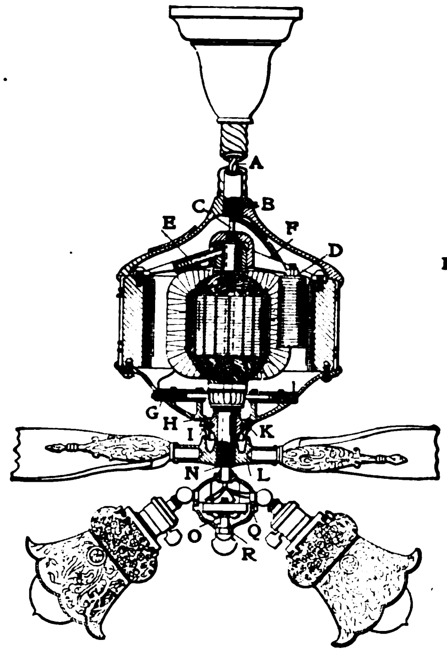


FIG. 49.—WESTERN ELECTRIC DIRECT-CURRENT CEILING FAN.

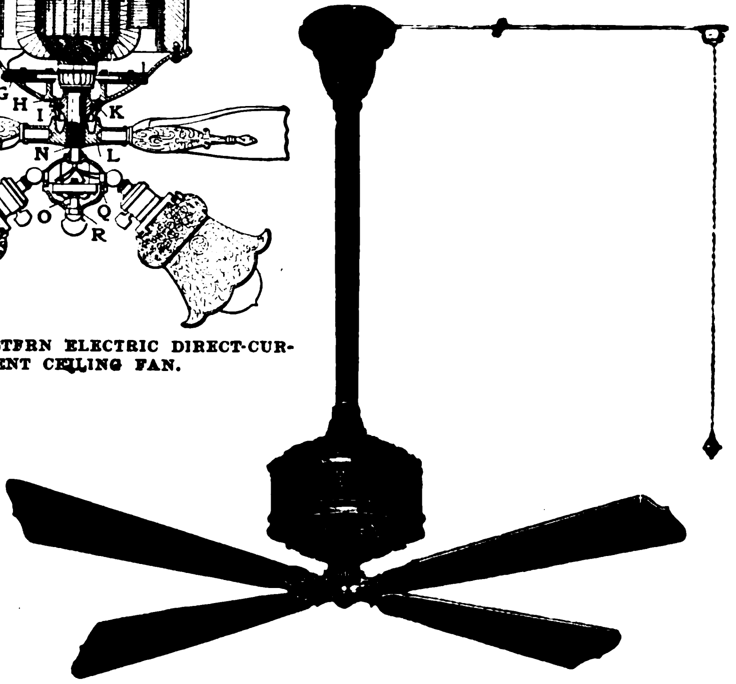


FIG. 51.—WESTERN ELECTRIC "ARCTIC" CEILING FAN.

Fig. 52 gives a sectional view of the 1901 model Standard direct-current ceiling fan motor built by the Robbins & Myers Company, Springfield, Ohio, and now in its fifth season. This fan is made in two general styles, designated by the company as Style A and Style B; the two styles differ from each other only in the construction of the field magnet and in external appearance. The pole-pieces and cores in the Style B fan motors are cast integral with the yoke ring; the pole-pieces have each one long and one short horn, as shown by Fig. 53, which is a view of the field magnet without the coils. The object of extending one pole-tip of each pole-piece is to obtain a greater area of air-gap, thereby decreasing its magnetic reluctance, without involving the provision of a removable pole-piece in order to put the field coil on or take it off. The field coils are rectangular, form-wound, thoroughly taped and finished with a baked insulating varnish; each coil is slipped on over the long pole horn, drawn to place, and then pressed over the short pole horn, which serves to hold it in position without any other mechanical fastening.

The field coils in the Style A motor are circular in form and are mounted on drop-forged magnet cores, which have each a pole-piece on one end and a curved face at the other; the magnet cores are bolted on to machined seats in the yoke ring, which is of cast iron. Fig. 50 illustrates this construction. The use of drop-forged magnet cores gives the Style A fan motor a higher efficiency than that of the Style B machine.

A novel feature common to both fans, and said to be found in no other fan motors, is an arrangement of a switch and resistance coil in fans operated in series, whereby any one fan of the series may be stopped without interfering with the operation of the other fans. A patent has been issued to the company covering this device.

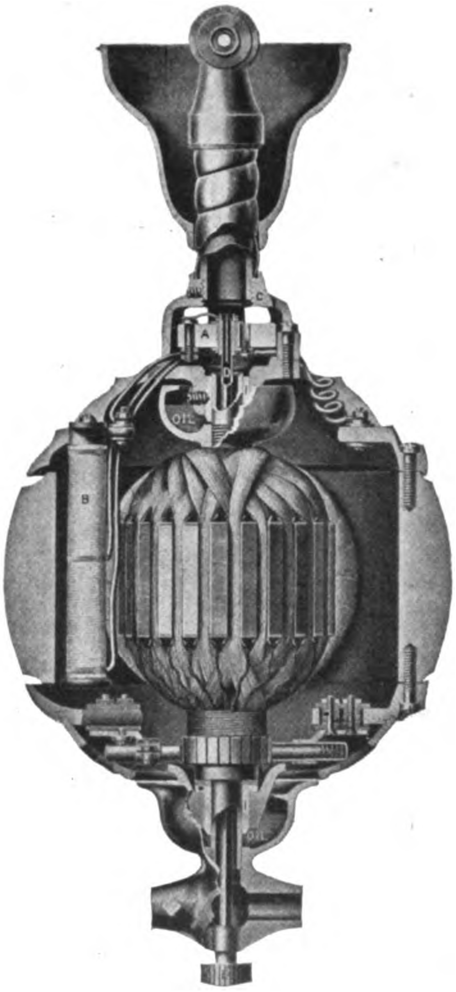


FIG. 52.—SECTION OF ROBBINS & MYERS DIRECT-CURRENT CEILING FAN MOTOR.

Reference to Fig. 52 will show that the bearings are supported and centered in end plates which together with the yoke ring form a spherical case enclosing the armature and field magnet structure. The company has adopted a new system of fitting these plates which secures absolute alignment of the bearings without resorting to swivel sleeves; the use of these sleeves has therefore been discontinued, with the result that the motor has greater rigidity and freedom from noise. The oiling system is too clearly shown by the engraving to require a detailed description. A marked bottle of oil is sent with each fan and the purchaser has only to empty half of the oil into each of the journal cups in order to prepare the fan for a season's run. The disposition of the regulating resistance and the porcelain switch are also clearly shown. These parts are connected up independently and may be placed in position or removed without disturbing any of the mechanism of the motor as there are no wires leading through the shaft as in previous models.

The direct-current desk and bracket fans made by the Robbins & Myers Company are illustrated by Figs. 54 and 55; these fans are now in their fourth season. The motors are designed on the same general plan as the Style B ceiling fan motor, having the peculiar arrangement of magnet poles shown in Fig. 53. The lubrication is accomplished in the usual manner with wick oilers, except that a special semi-solid lubricant is used which, it is claimed, cannot be thrown out by the fan after it works through the bearings. The guard is of familiar design and made entirely of brass. The motors are all mounted in swivel trunnion frames, which allow universal adjustment of the direction of the air current. These motors are also provided with the patent switch arrangement for series operation, which allows any one fan to be stopped independently of the others.

Fig. 56 illustrates the desk fan motor built by the B. B. Electric Company. The motor is of the bipolar type, having a cast-iron field magnet cast in a single piece, with openings large enough to admit the field coils and armature. The armature is of the usual drum type, wound in slots. The brushes are of carbon, rectangular in shape, sliding in brass holders and pressed against the commutator by helical springs. A ball-and-socket joint enables the motor to be used on a desk or mounted on a wall, and a resistance coil and switch in the base provide three speeds. Lubrication is effected by wick-feed oil cups. When assembled, the working parts are entirely enclosed. The motor is built for 115 volts, and the 12-in. fan is driven at 1800 r.p.m., with a current consumption of 0.35 ampere.

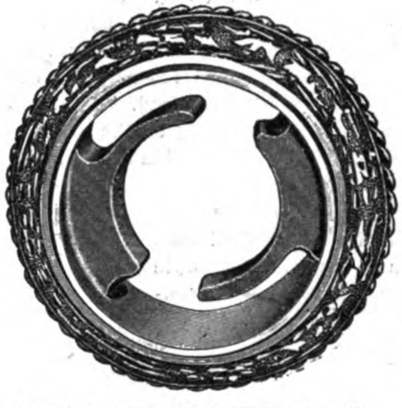


FIG. 53.—ROBBINS & MYERS FIELD MAGNET.

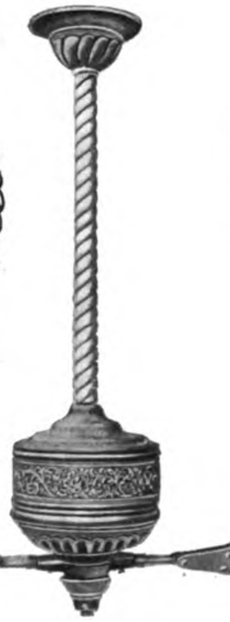


FIG. 57.—PARAGON DIRECT-CURRENT CEILING FAN MOTOR.

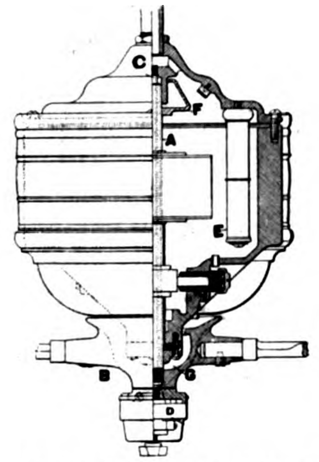


FIG. 58.—SECTION OF PARAGON CEILING FAN.

Fig. 57 illustrates the Type D Paragon ceiling fan motor built for direct-current circuits, and Fig. 58 is a semi-sectional view of the same machine. The motor is a bipolar machine with a drum armature wound in slots. The motor shaft is supported in bearings top and bottom, and the bearings are provided with grease retaining cups, F and G. The brushes are of the carbon-pencil or cartridge type, mounted in the lower framework of the field magnet. They are entirely enclosed in the Type D fan by the lower part of the ornamental casing. These machines are wound for 100, 120, 220, 250 and 500 volts; the current consumption is 0.82 ampere at the lowest voltage, 0.43 ampere at the intermediate voltage, and 0.24 ampere at 500 volts.

Another efficient ceiling fan of the same general type as the one just described is the "Peerless" Type H machine built by the Warren Electric & Specialty Company, and illustrated by Fig. 61. The general design is precisely the same as that of the Paragon machine. The shaft carries an oil cup at the top and bottom, so that the bearings are constantly submerged in oil. The bearing shells have curved seats, making them self-aligning. A noticeable detail of this machine is the manner in which the fan-blade hub is put on. The lower oil cup, instead of being cast integral with the fan-blade hub, making it necessary to remove the oil cup in the event that the fan-blade hub needs to be removed, is entirely separate and mounted permanently on the shaft. The oil cup is provided at the bottom with wings corresponding to the arms of the fan-blade hub, and the two are bolted to-

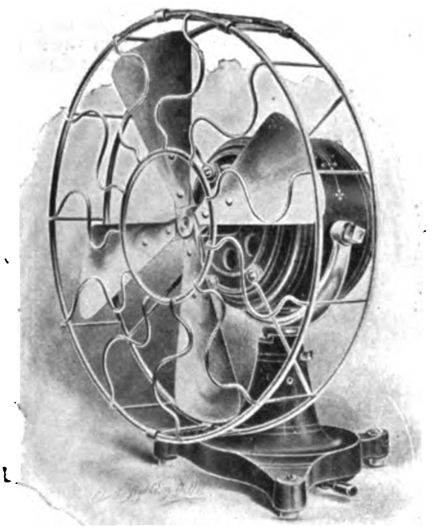


FIG. 54.—ROBBINS & MYERS DESK FAN MOTOR.

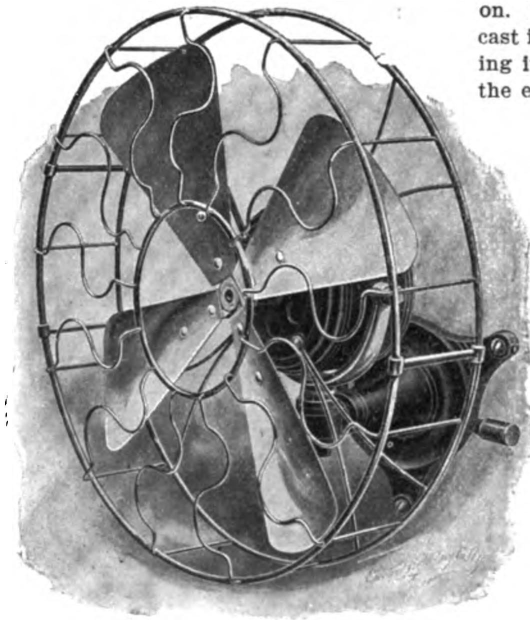


FIG. 55.—ROBBINS & MYERS BRACKET FAN MOTOR.

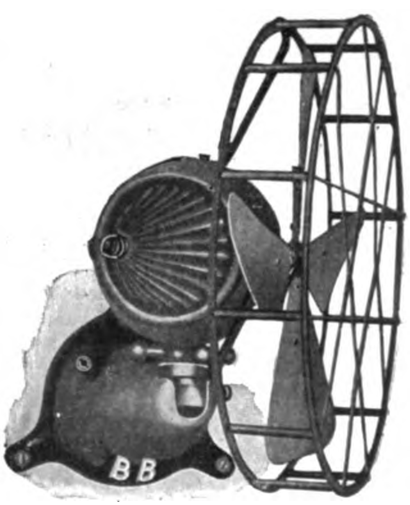


FIG. 56.—B. B. FAN MOTOR.

gether, as indicated in the engraving. The shaft is hollow in order to allow the switch spindle to extend upward to the switch, which is located at the top of the canopy. Two speeds are available, the rheostat controlled by the switch being located in the upper part of the fan structure. The commutator and brushes are of the familiar type, the latter being graphite-carbon pencils mounted in tubular shells, which are enclosed in insulating sleeves through the lower part of the casing. This fan is wound for 110, 170, 220, 250 and 500 volts. The current consumption at these voltages is 1 ampere, 0.7 ampere, 0.55 ampere, 0.45 ampere and 0.23 ampere, respectively. This fan is furnished with either two blades or four; with two blades the speed is 130 r.p.m., and with four it is 110 r.p.m. The Warren Company has also brought out a new fan this season known as the Midget, which has a sweep of 24 ins., instead of the 60-in. sweep of the Peerless fan, and has a speed of 500 r.p.m. This fan is wound for all the voltages just mentioned except 500. It is not provided with a **regulating switch, but is intended to be used in connection with a wall controlling switch.**

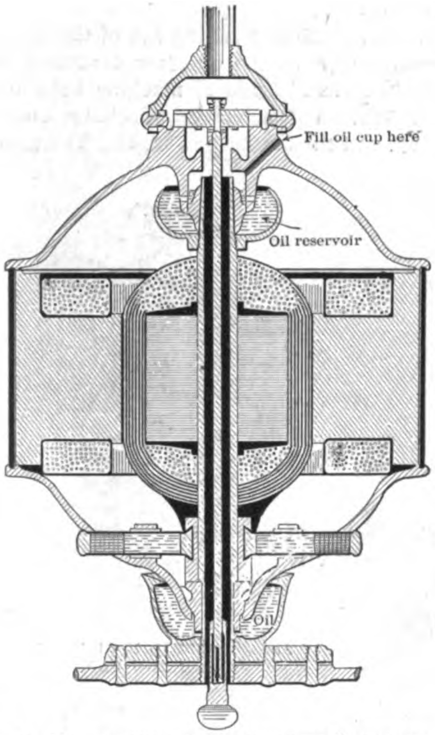


FIG. 59.—SECTION OF "PEERLESS" CEILING FAN MOTOR.

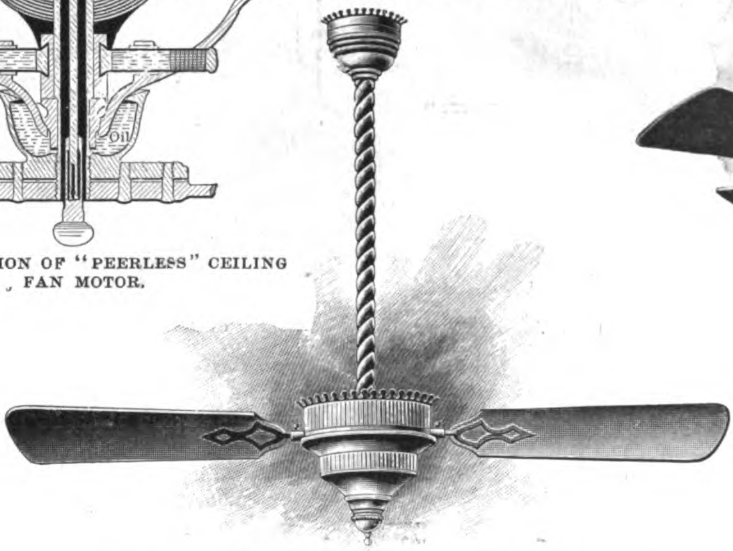


FIG. 60.—DIEHL STANDARD DIRECT-CURRENT CEILING FAN.

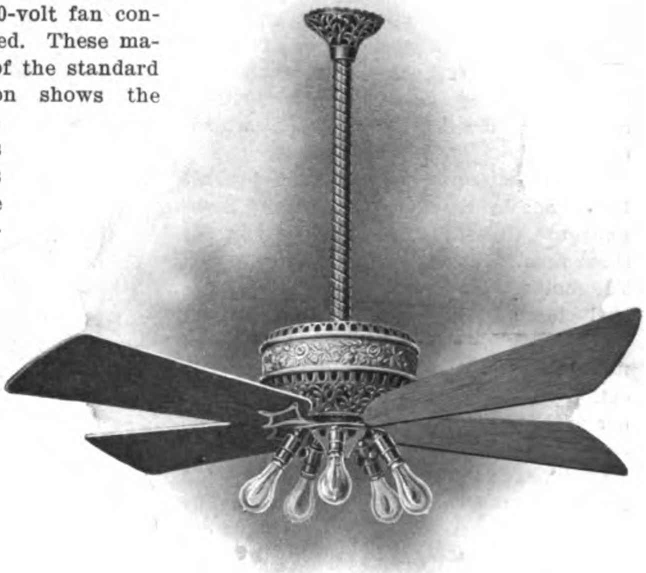


FIG. 62.—BATES DIRECT-CURRENT CEILING FAN.

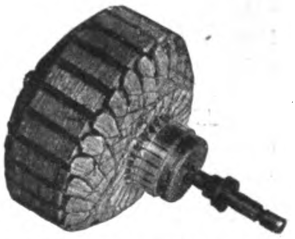


FIG. 63.—BATES DIRECT-CURRENT MOTOR ARMATURE.

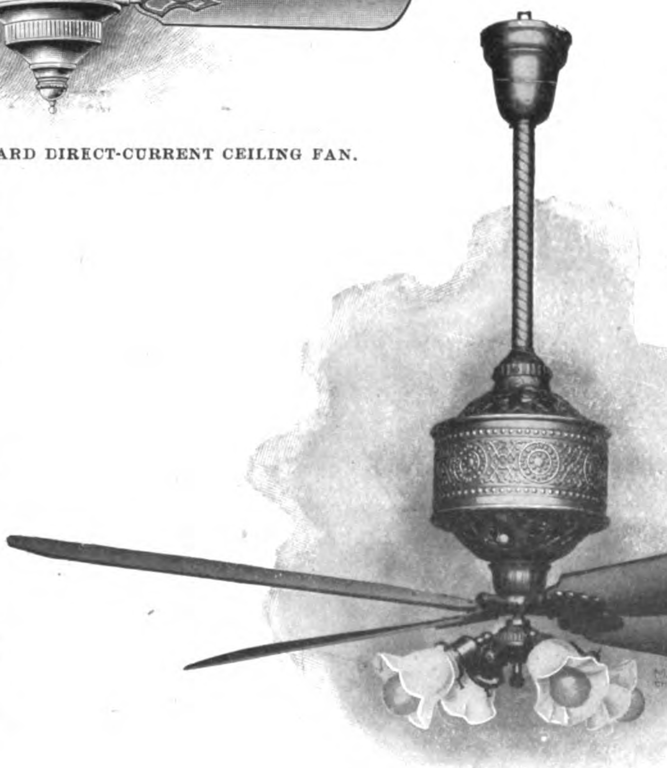


FIG. 61.—"PEERLESS" CEILING FAN.

The Bates Style A direct-current ceiling fan is illustrated by Fig. 62. It is a 6-pole machine with inwardly projecting (radial) pole-pieces, and form-wound interchangeable field coils individually insulated and securely wedged into place. The armature, which is illustrated by Fig. 63, is of the drum type, of large diameter, and has an unusual area of radiating surface; only two brushes are employed. The armature coils are form-wound and individually insulated before being placed in the slots. After the armature is completed it is dipped into an insulating varnish and baked in an oven until it is thoroughly dried out. The commutator and brushes are of the usual type, the latter being round carbon pencils in cartridge holders. The 110-volt fan consumes 85 watts at full speed. These machines are wound for all of the standard voltages. The illustration shows the revolving electrolier type of fan, but of course it is supplied without the lamps when so desired. The style A fan has no speed regu**lation. Messrs. Bates & Bro. built a similar fan, however, known as the Imperial, which is equipped with a three-speed switch.**

Fig. 60 illustrates the Diehl standard direct-current ceiling fan. This machine is provided with a bipolar field magnet of laminated sheet-iron, and a Gramme ring armature of the external type. This arrangement obviously gives a very short magnetic circuit, resulting in corresponding economy in field excitation and current consumption. A radial commutator is located below the armature, and carbon brushes of a modern type are employed. **This machine is built for all of the standard direct-current voltages and for 170 and 250 volts also. The sweep of the fan blades is 60 ins. The fan is provided**

with a three-speed regulator when desired. The Diehl Company also builds a ceiling fan, the motor of which is of a design similar to the desk fan motor previously described.

The Eclipse ceiling fan (Geo. C. Towle Manufacturing Company) is illustrated by Fig. 64. The motor has a multipolar field magnet cast in a single piece and provided with form-wound coils. The armature is of large diameter and has 29 coils. The motor is encased in a polished brass cover which may be removed by simply unscrewing the switch button at the bottom of the motor. The fan is ordinarily furnished with four blades, and runs at 150 r.p.m. The machine is wound for 110, 170, 220, 250 and 500 volts.

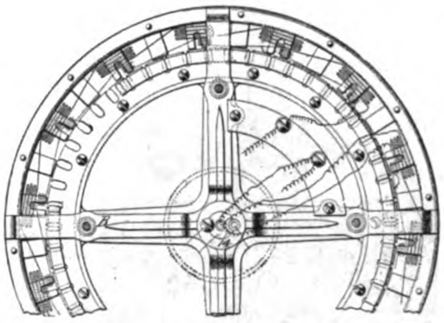


FIG. 65.—DIAGRAM OF EMERSON "SPECIAL" MOTOR WINDING.

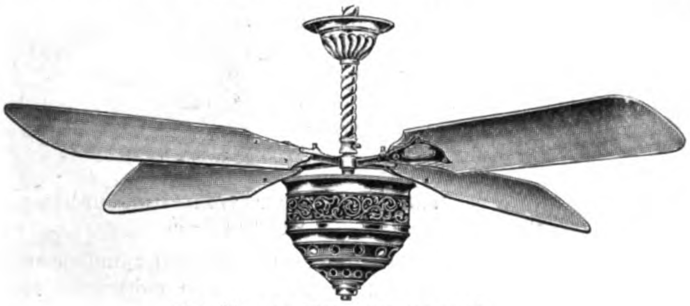


FIG. 64.—ECLIPSE CEILING FAN.

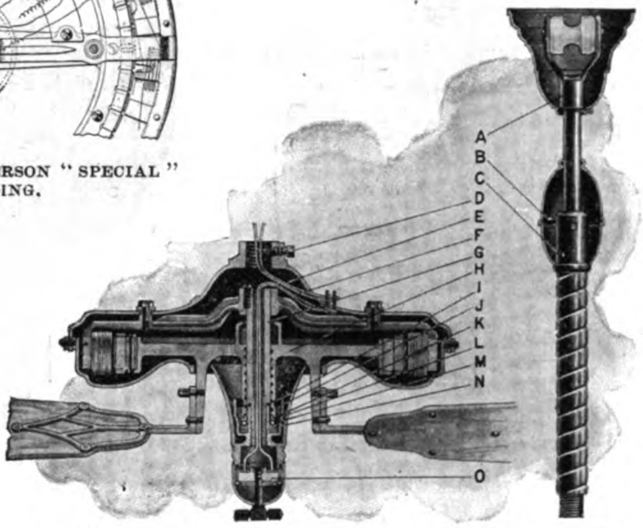


FIG. 67.—SECTIONAL VIEW, EMERSON CEILING FAN MOTOR.

One of the very few alternating-current ceiling fan motors is the Emerson machine, which is represented by Fig. 68. This is an induction motor, and its general construction is clearly indicated by Fig. 67. The field magnet has 28 poles, each divided into two parts by a slot in the center. The object of this construction is to allow the use of shading coils, each wound on half a magnet pole, as described in connection with the desk fan motor of this company. The coils are form-wound and individually insulated before being put in place. The armature is of the squirrel-cage type, and the conductors are flat copper strips similar to those on the Emerson desk fan rotor illustrated by Fig. 13, and previously described. The accuracy of the stampings is not relied upon, but the armature core is turned to size after the discs are assembled in order to reduce the air-gap to the smallest possible clearance allowable by mechanical conditions. The armature, like that of the desk fan motor, is provided with a hollow shaft, and revolves about a stationary spindle. The weight of the armature or rotor is taken by a thrust ball bearing, shown at N. The oiling arrangement is unique. The oil reservoir, K, is located at the bottom of the bearing, and the bore of the shaft is provided with a spiral groove, similar to a screw-thread, which raises the oil to the top of the bearing, whence it trickles down again, keeping the bearing thoroughly lubricated. This machine is built for 52, 104 and 110 volts, and for use on 60-cycle circuits. It has two speeds, namely, 210 r.p.m. and 160 r.p.m. The switch is arranged so that the shading coils may be cut out after the machine has been started, and this gives the lower speed. This motor is also supplied for 133-cycle circuits, but the high-frequency type has only one speed, which is about 500 r.p.m., and is equipped with five fan blades, the sweep being 30 ins. instead of the usual 56-in. sweep.

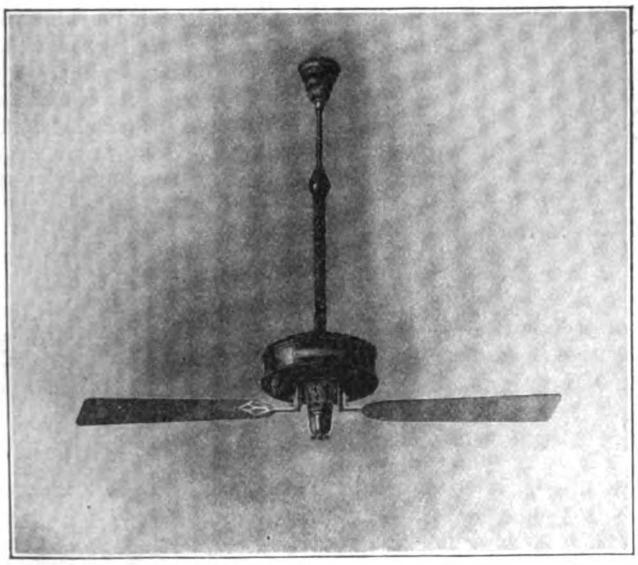


FIG. 66.—EMERSON "SPECIAL" MODEL CEILING FAN.

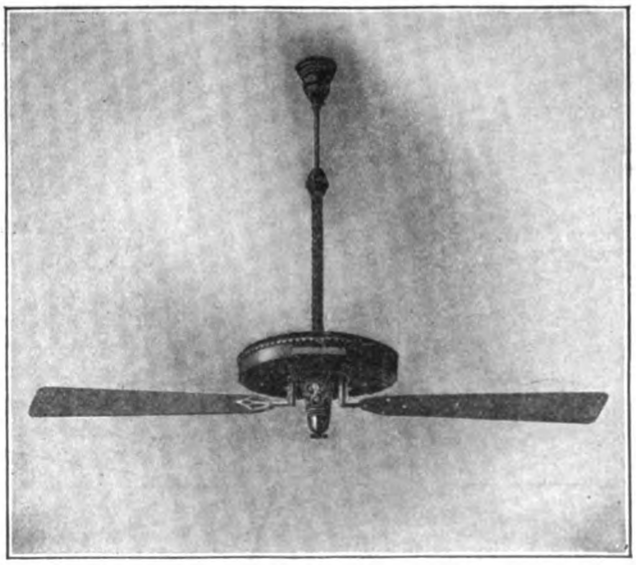


FIG. 68.—EMERSON STANDARD CEILING FAN.

Fig. 66 illustrates the Emerson "special", model ceiling fan, which is of almost exactly the same construction as the standard model. There is a difference, however, in the field construction, as an inspection of Fig. 65 will show. Instead of splitting every magnet pole and providing coils for all of the poles, only the alternate poles are split and wound, the intermediate poles being consequent. This winding makes the fan more compact, as the wireless poles are not so wide angularly as those which carry coils. The blades have a 50-in. sweep as compared with 56 ins. in the standard model, and the speeds are the same. This machine is only built for 60-cycle circuits, and for 104 and 110 volts.

The Empire ceiling fan motor of the Sprague Electric Company is illustrated by Fig. 75. As will be seen in the engraving, it is of the four-pole radial magnet type and has but two brushes, set 90° apart. A cross-sectional view through two of the magnet cores is given by Fig. 69, which also shows the deep oil cup that surrounds the hub of the armature—a notable feature in the construction. The armature is a slot-wound drum and is illustrated by Fig. 70. The speed is 135 r.p.m., and the voltages and current consumption are as follows: 110 volts, 0.95 ampere; 165 volts, 0.64 ampere; 220 volts, 0.57 ampere; 250 volts, 0.53 ampere.

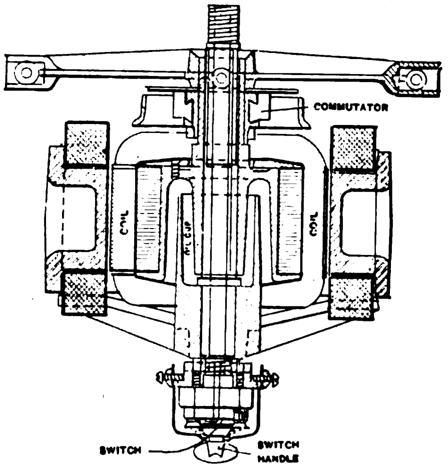


FIG. 69.—SECTION OF EMPIRE CEILING MOTOR.

The Backus direct-current ceiling fan is illustrated by Fig. 71. The motor has a bipolar field magnet and a Gramme ring armature, as indicated by the sectional view, Fig. 72. The field is of the Vanderpoele type with the armature shaft bearing passing through the center of the field magnet core, and a form-wound exciting coil located on each side of the bearing. The upturned pole-pieces embrace a high percentage of the armature core, giving an air-gap of large area and consequently small reluctance. The brushes are carbon pencils disposed parallel with the shaft, a commutator of the radial type being used. The main bearing is located immediately beneath the armature, a grease cup being formed in the field magnet frame at that point. An auxiliary bearing is located at the lower extremity of the structure where another grease cup is formed in the casting. These fans are built for 110-115 volts, 170 volts, 220-250 volts and 500 volts. The 110-115-volt and 220-250-volt fans are provided with variable-speed switches; the thumb piece of the switch extends below the center of the fan-blade hub. The normal speed of the fan is 170 r.p.m., and the power consumption is about 100 watts with fan blades having 57½ ins. sweep.

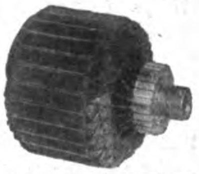


FIG. 70.—ARMATURE OF EMPIRE CEILING FAN MOTOR.

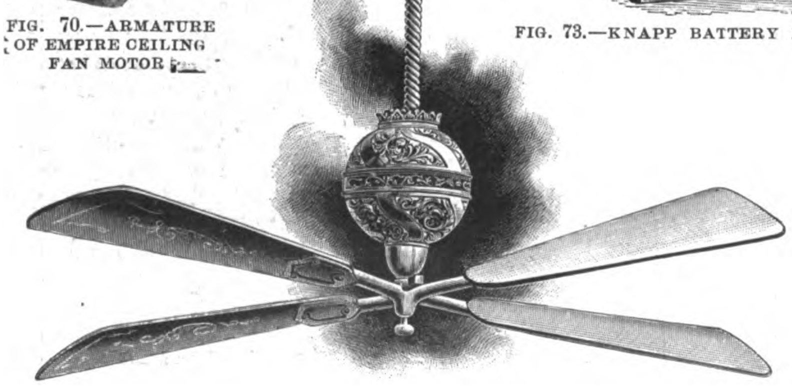


FIG. 71.—BACKUS DIRECT-CURRENT CEILING FAN.

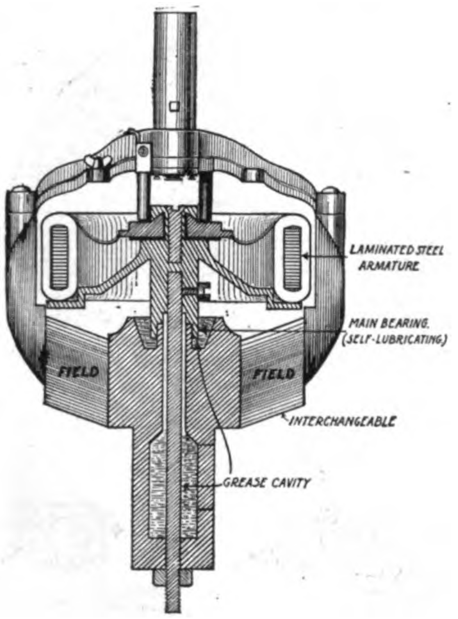


FIG. 72.—SECTION OF BACKUS FAN MOTOR.

The only other alternating-current ceiling fan which has not been described is the Tuerk machine, built by the Hunter Fan & Motor Company. A special feature of this machine is the use of a high-speed motor with a speed-reducing gear between the motor spindle and the fan blades. The fan blades are attached to the lower part of the casing of the machine, and this casing consequently revolves. Its motion is received from two leather-faced friction wheels which are mounted on short individual spindles and arranged to transmit the motion of the armature spindle to the casing. The result is the same as though a pinion of the diameter of the armature spindle were used to drive a gear on the casing of the diameter of the friction surface upon which the intermediate wheels bear, and of course the difference in speed is correspondingly great. The speed of the fan blades has been increased since last year, and is now 175 r.p.m., with a consumption of about 110 watts. The machines are built for the usual frequencies, and for 52, 104-110 and 208-220 volts.

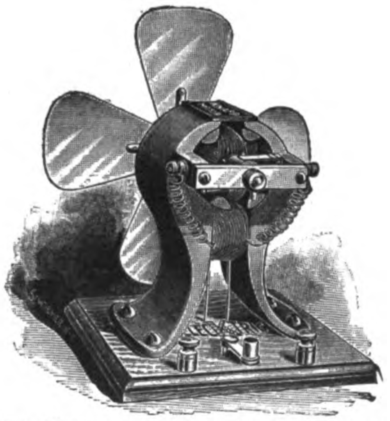


FIG. 73.—KNAPP BATTERY FAN MOTOR.

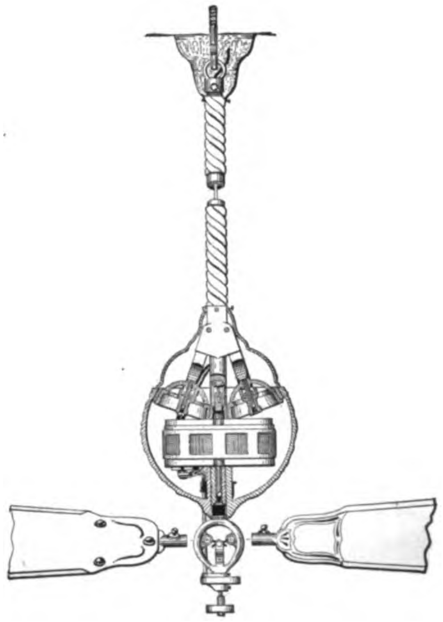


FIG. 74.—TUERK ALTERNATING-CURRENT CEILING FAN.

Among the little fan motors built to operate on battery current, one of the most familiar is the Knapp machine, illustrated by Fig. 73. This is known as the type C motor of the Knapp line. The armature has six projections or teeth, and is provided with a six-coil Siemens winding. The motor drives an 8-in. four-blade fan at 1800 r.p.m. when it is supplied with current from three cells of battery. The battery is a carbon-zinc primary cell and is usually enclosed in a wooden case.

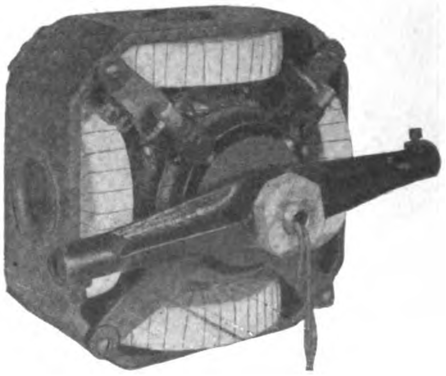


FIG. 75.—EMPIRE CEILING MOTOR.

Fig. 76 shows a little battery motor

known as the "Oddo Wilfan," built by Jas. H. Mason. The armature of this little machine has a three-pole core with three coils, and drives a six-inch fan at 2200 r.p.m. The engraving shows the fan resting on top of a box which is intended to be filled with gravel, a ballasted foundation, so to speak. The battery used with the motor is a bichromate-of-potash cell, being a modification of the Grenet electropoion type. The electrolyte consists of nine pints of water in which are dissolved ⅛ lb. of saltpeter and 1 lb. of bichromate of potash, to which is added 1½ lbs. of commercial sulphuric acid.

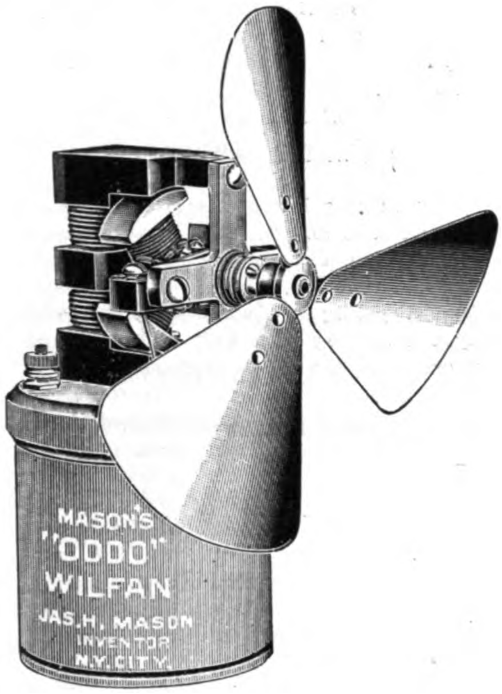


FIG. 76.—"ODDO WILFAN" BATTERY FAN.

Another interesting little machine is the Arctic battery fan motor, shown by Fig. 77. This motor is of the familiar bipolar type and built by the American Electric Company. It is made in several sizes; the one illustrated is known as No. 3, and is designed to run a 9-in. four-blade fan at 1600 r.p.m. when supplied with current from three cells of a modified form of Fuller battery.

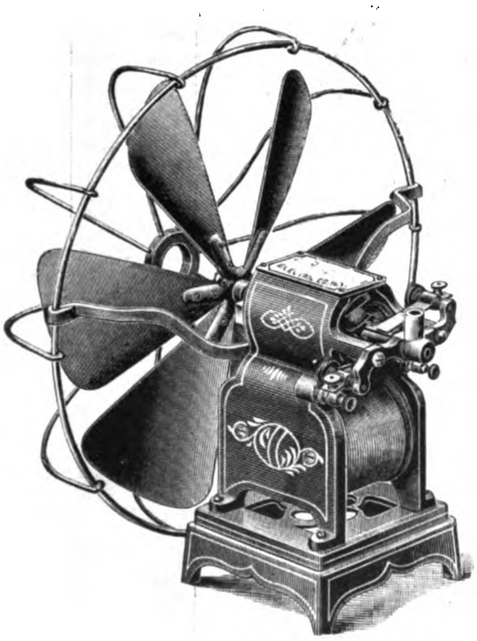


FIG. 77.—ARCTIC BATTERY FAN MOTOR.

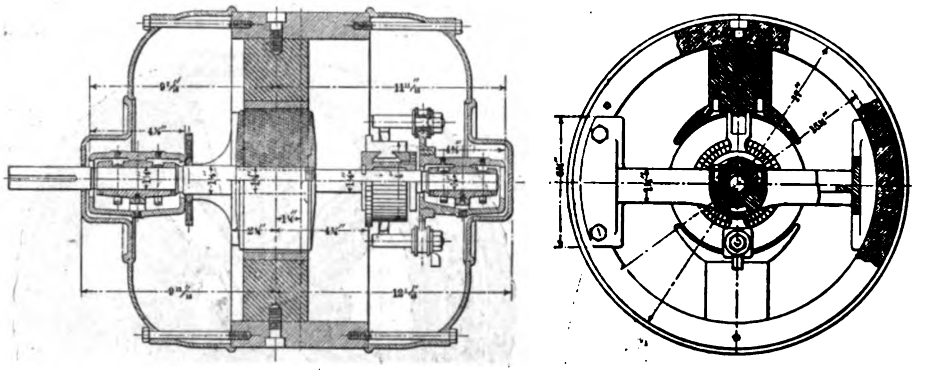


FIG. 78.—LATEST TYPE OF STURTEVANT 4-POLE VENTILATING FAN MOTOR.—FIG. 79.

The brushes are of copper leaf but are mounted in pivoted spring brush holders, like those of large machines.

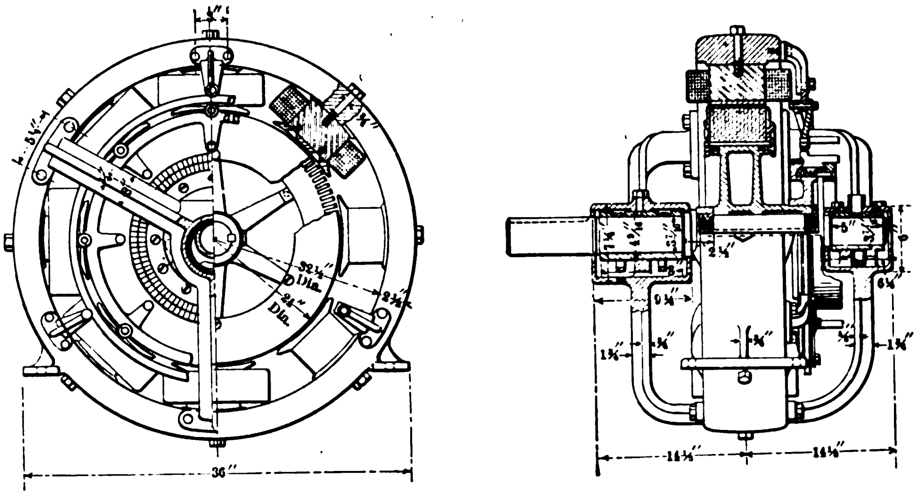


FIG. 80.—LATEST TYPE OF 8-POLE STURTEVANT VENTILATING FAN MOTOR.—FIG. 81.

The binding posts have rubber bushings in the wire holes, so that there is no connection with the battery until the binding post screws are set up. The object of this is to avoid cumbering the little machine with a switch; it is cut in and out by simply setting or unsetting one binding post screw.

Fig. 82 illustrates the latest form of Sturtevant ventilating fan and motor outfit. The motor is of the bipolar type and entirely enclosed, as the illustration indicates. Fig. 78 is an axial cross-section of the motor, and Fig. 79 is partly a transverse section and partly an end view with the cap removed. The armature bearings are contained in journal yokes of the ordinary type, bolted to and extending outward from the field ring. The magnet cores are wrought iron, bolted to the ring, and the pole-pieces are cast-iron and bolted in turn to the cores. The end caps are entirely independent of the remainder of the machine, and can be removed while the machine is running without interfering in the least with its operation. This type of motor is built for use with fans ranging from 18 ins. to 54 ins. diameter. For fans larger than 54 ins. four-pole and eight-pole motors are employed. The eight-pole motor construction is clearly indicated by the sectional views, Figs. 80 and 81. The field ring is of cast steel in the medium-size machines, and of cast iron in the large sizes. The field cores are of wrought iron and the pole-shoes of cast iron. The field coils of both the bipolar and multipolar types are machine wound.

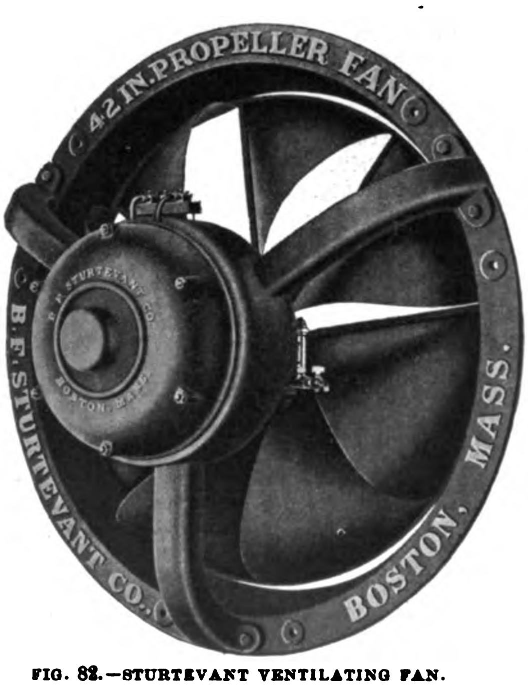


FIG. 82.—STURTEVANT VENTILATING FAN.

The armature core discs are clamped between end plates of a diameter equal to the extreme diameter of the core discs and slotted correspondingly, this construction being used in order to clamp the teeth as well as the body of the discs. The armature coils are form-wound, the armature being of the drum type. A modified form of reactive carbon brush is employed on all of the machines. The fan blades are of propeller design, gradually assuming a helical shape toward the outer edges. The object of this construction is to pick up the air at low velocity and accelerate it during its passage from the inner to the outer edges of the fan blades.

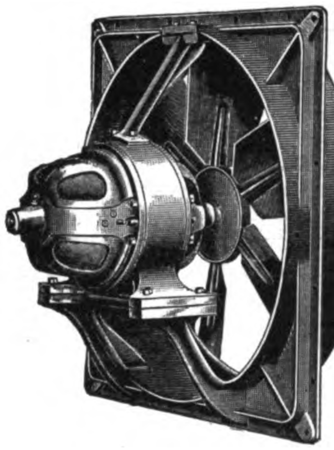


FIG. 83.—TRIUMPH VENTILATING FAN.

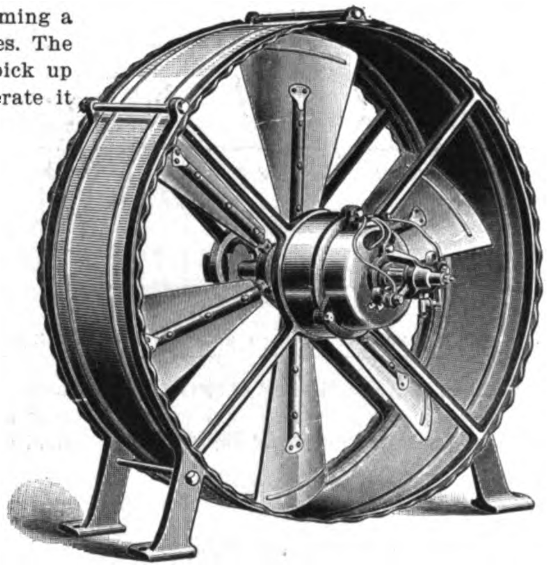


FIG. 84.—WING VENTILATING FAN.

The Fuller ventilating fan, illustrated by Fig. 85, has blades shaped like segments of a screw-thread; that is to say, if each blade were continued around until it completed a circle it would be a perfect screw-thread of one turn. The motor, as the engraving plainly shows, is a four-pole machine with four radial arms cast integral with the field ring, by means of which the motor is fastened to the fan casing. The armature has a drum winding and the coils are form-wound and insulated before going on the core. The brushes are of the reaction type, modified in order to allow the motor to run in either direction without changing their adjustment. The bearings are lubricated in the usual manner by an oil ring on the shaft. The outer periphery of the oil ring is notched in order to increase its capacity for carrying oil.

The Triumph ventilating outfit, illustrated by Fig. 83, is built by the Specialty Manufacturing Company, and comprises an enclosed multipolar motor mounted on a bracket which is cast integral with the fan frame. This method of mounting has been adopted in order that the motor might be available for other purposes when the service of the fan is not desired, in which case the motor can be readily removed from its bracket and a pulley substituted for the fan on the end of its shaft. The motor is of the latest modern design, provided with self-feeding carbon brushes, self-oiling bearings, and a starting rheostat with automatic release. A feature of the fan casing is the square frame which is cast on the periphery of the circular ring surrounding the fan blades. This allows the apparatus to be installed in an ordinary rectangular opening without making special provision for it.

Fig. 84 illustrates the ventilating fan and motor combination of the L. J. Wing Manufacturing Company. The motor is a four-pole machine with laminated magnet cores and pole-pieces bolted to a soft-steel yoke ring. The armature is drum-wound and provided with form-wound coils of the barrel type, insulated, of course, previously to being placed on the core. The armature discs are insulated from each other by japanning, and air ducts are provided for ventilating the core and winding. The motor is secured to the fan frame, as the engraving shows, by four radial arms, and the fan is mounted directly on the motor shaft.

The method of lubricating fan motors by means of wick-feed oil cups has grown to be almost universal practice, most of the machines being provided with oil cups of the type illustrated by Figs. 86 and 87. These cups are substantially made of brass, and the wick is stiffened by being mounted in a long sleeve turned solid with the enclosing cap of the cup. The lower end of the wick is embraced by the upper end of a conical spring, which provides a simple means of adjusting the pressure of the spring. The upper convolutions of the spring clasp the wick so tightly that the maximum pressure of the spring cannot cause it to slip on the wick. At the same time the wick may be twisted through the spring by hand so as to increase the compression of the latter. This cup is made by the Bowen Manufacturing Company, and is known as Style H.

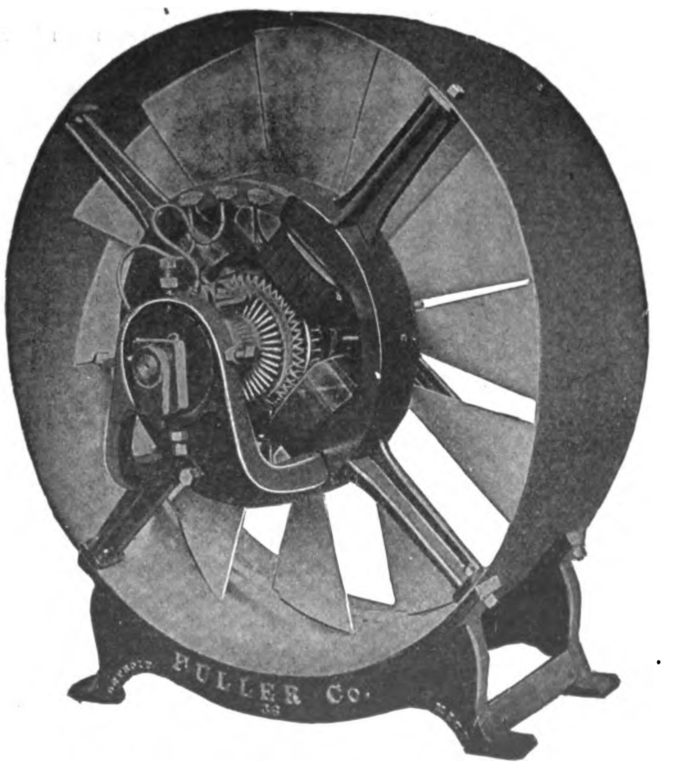


FIG. 85.—FULLER VENTILATING FAN OUTFIT.

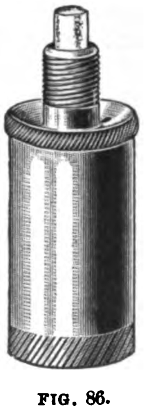


FIG. 86.

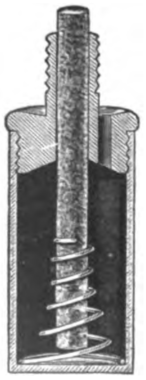


FIG. 87.

WATER HAMMER.

Sometimes a line of steam piping sags because it is insufficiently supported and its own weight causes it to bend between adjacent supports; again, very accurately leveled piping is occasionally distorted by the settling of a wall or foundation upon which one of the supports rests. In either case there is liable to be formed a gathering or "pocket" of condensed water by drainage to the "sag" from both directions, while the plant is temporarily idle or after it is shut down at night. Then when steam is again turned on and reaches the pocket of water it will tend to evaporate the water; but, owing to the conditions of temperature being usually unfavorable for complete evaporation of the mass of water at once, it will, it is generally believed, be partially evaporated and again condensed, alternating rapidly between the two conditions, and producing the familiar pounding or hammering that we are so well acquainted with in steam pipes. If, unfortunately, the conditions of temperature happen to be favorable, the whole mass of pocketed water may be temporarily evaporated and carried along the pipe as steam and at steam's velocity, only to be condensed back into water further along the pipe, in which event the recondensed mass of water will be moving at the high rate of several thousand feet per minute. If it encounters an elbow or other fitting, the fitting is almost sure to be wrecked. Such an accident took place in Detroit, Mich., a few years ago, when an elbow in an 8-in. pipe was smashed and much damage done to the building. In order to avoid this contingency it is essential that care be taken not only to turn on steam slowly and to warm up the pipes carefully at starting, but also to locate all possible sags and depressions in the steam pipe for the purpose of releveling, or of tapping for drain-cocks. Furthermore, in view of the destructive possibilities of this water-hammer or explosive boiling, steam drums and headers which are connected up so that all inlets and outlets are on the side or top, leaving no opportunity for condensation to drain out, should be tapped for drain cocks at their lowest points.

Besides the troubles already mentioned, water of condensation in pipes has the serious disadvantage of causing pitting and cutting grooves when running along a pipe in a stream. Instances have been known where this grooving action has been so great at elbows as to cut entirely through the metal. An effort has been made in modern practice to eliminate this trouble by running a small pipe immediately beneath the main pipe, the two being connected at frequent intervals by short vertical pipes. The small pipe drains all the water out of the steam pipe, and may be so connected as to return the drain water back to the boiler directly.

Abstracts from Foreign Contemporaries

Modification of the Hughes Telegraph Keyboard.—In a recent issue of the London "Electrical Review" C. H. Garland describes Signor Paolo Fauret's modified Hughes keyboard now being used between Milan Bourse and Rome. It consists in a rearrangement of the figure keys as shown by Fig. 1. Ordinarily the figures form a consecutive series running from left to right without interruption, and the modification was devised with a view to obviating certain inconveniences found with this arrangement in practice. It is said to be favored in commercial and stock exchange work, where many figures are employed, and also in all the figure codes, being easier of manipulation.

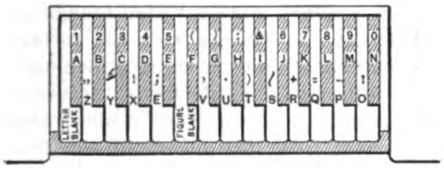


FIG. 1.—HUGHES KEYBOARD.

Bolt for Connecting Storage Battery Lugs.—In a recent number of the London "Electrical Engineer" is described a bolt devised by W. O. Rooper, for connecting storage battery lugs, by means of which any plate in any cell can be quickly removed and replaced. Fig. 2 shows its construction. Each plate has a jaw formed on its lug, and through these jaws is passed a lead-coated pin; spacing washers keep the jaws in position, and the whole is tightened by means of patent nuts which are not affected by acid. The joints, it is said, may be left in strong acid without harm, and no trace of corrosion is found on removal.

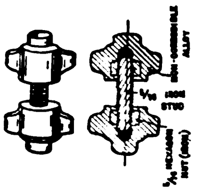


FIG. 2.

A New Electrolytic Interrupter.—The "Physikalische Zeitschrift" in a recent issue describes a new interrupter devised by W. A. Hirschmann, which is illustrated herewith. A hollow piece of ebonite, H, Fig. 4 revolves with the shaft, A, and is provided with two copper contacts, M, with inlets into the interior of the ebonite as shown at T and U, Fig. 4. The other contact, C, is pressed against the contact, M, by the spring, F. The opening, B, in the ebonite block is so arranged that it scoops up the mercury in the bottom of the apparatus into the interior of the block and forces it out through the apertures at T and U. The contact P serves to spread the issuing mercury over the contacts, M, thus keeping them amalgamated. The apparatus works noiselessly in an accumulator circuit or a 110 or 220-volt supply circuit.

A New Steam Stop Valve.—In a recent issue of "Engineering" is described an interesting steam stop valve, the construction of which is such as to leave the spindle and seat free to expand and contract under changes of temperature without affecting the seating of the valve disc. The construction is shown in the sectional view herewith (Fig. 3), which is almost self-explanatory. The valve disc is provided with an auxiliary seat which is fitted to the body seat by means of a flat ground joint. The yoke into which the spindle is threaded, instead of being bolted solidly to the cap of the valve, is held down by heavy coil springs, as shown. These springs are adjusted to exert a pressure of 50 lbs. above the maximum boiler pressure, so that the valve may be mounted with the boiler pressure against the under side of the disc without incurring liability to leakage. A distance ring is provided on the valve spindle to prevent jamming the valve beyond the amount necessary to render it steam-tight. The auxiliary seat is provided with a guide slot to take the guiding lug on the bottom of the valve disc.

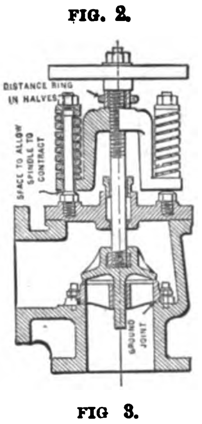


FIG 3.

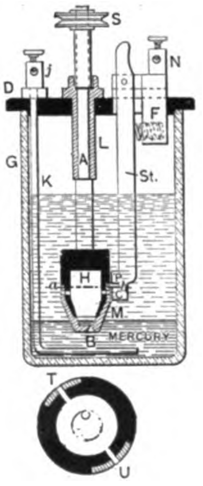


FIG. 4.

Three-Phase Motors for the London Metropolitan Underground Railway.—Complete particulars concerning the London Metropolitan Underground Railway being as yet unobtainable from Ganz & Co., the contracting engineers for the electrical equipments, the London "Engineer" publishes a description of the Valtellina Railway in the Lake Como district of Italy installed by the same concern, and which the London railway will closely resemble, differing only in some minor details. Thus, on the Italian line each motor truck carries two motors, whereas in London each front and rear motor car will carry four motors, or eight for each train. In both schemes two trolley wires and the rails carry three-phase currents. The line current in Italy is carried at 20,000 volts; but it is proposed to use 3000 volts in London. Contact with the rails is formed by the driving wheels, as in ordinary trolley practice. Every conductor from the trolley wires is incased in metal as a safeguard against accident. The motors are three-phase induction motors and are arranged in pairs for high and low tension. Each consists of a high-tension stator and a low-tension rotor. Current at 3000 volts enters the stator of the high-tension motor from the trolleys and the rails, and induces in the rotor lower voltage three-phase currents which, during starting and up to half speed, are taken to the stator of the low-tension motor. The currents induced in the rotor of the latter are passed through a non-inductive liquid rheostat the resistance of which is automatically reduced from maximum to zero. At half speed the low-tension motor is cut out of the circuit, thereafter running idle, while at the same instant the full rheostat resistance is switched out of its rotor circuit into the rotor circuit of the high-tension motor, where it is once more automatically reduced from maximum to zero during the acceleration from half to full speed. In slowing down this series of operations is reversed. To half speed the retardation is entirely electrical, and during this period three-quarters of the kinetic energy of the train is said to be absorbed and pumped back into the line as three-phase currents by the dynamo action of the motors, while the other one-fourth is dissipated by the brakes.

The mechanical mounting of the motor and the method of driving the wheels are features of the system. The wheels are keyed in the ordinary way upon an axle which passes through the core of the rotor; the latter being connected to each driving wheel by five tangential links through which the motion of the rotor is transmitted to the wheels.

High Voltage Arc Lamp Trouble.—In a recent issue of the London "Electrical Review" J. G. Griffin describes a method of dealing with the high voltage arc lamp trouble with which Burnley and other British towns were suffering after the voltage at the customers' terminals had been raised from 105 to 220. It was found that the 220-volt arc gave more heat, the carbons lasted but half the time, the light was unsteady, and the lamp gave but one-fifth of the light, and that fifth was of such an inferior quality that it was impossible to distinguish the different shades of colored materials. Failing to remedy the evil they finally returned to the old 105-volt lamps, supplying them from a five-wire system, as shown in Fig. 5. Here A is the main generator, B, B, two machines forming the three-wire balancers. Two small balancers, CC, DD, are connected across both sides of the three-wire system, as shown, and from the middle wires of these small balancers cables, E and F, are run to the afflicted arc lamp district. The lamp is then connected to this new service wire and one of the mains already on the premises. The balancers were coupled together, having their fields cross-connected, which made them nearly self-regulating. Ordinarily the balancers were run only five afternoons and evenings per week. Should a customer desire to use his lamps at any other time, he signalled to the station by an arrangement shown in Fig. 6. Two 32-c.p. lamps, I and J, are connected in series on each side of the main neutral wire, and the center wire from these lamps is connected through a bell to the arc lamp balancing wire on that side of the system. Throwing in the arc short-circuits one of the incandescent lamps permitting current to pass through the bell, causing it to ring, and making the other incandescent lamp glow brightly. The switchboard attendant starts up the proper balancer as soon as the bell rings.

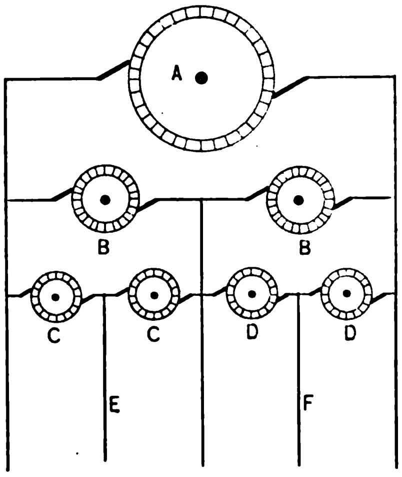


FIG. 5.—FIVE-WIRE SYSTEM.

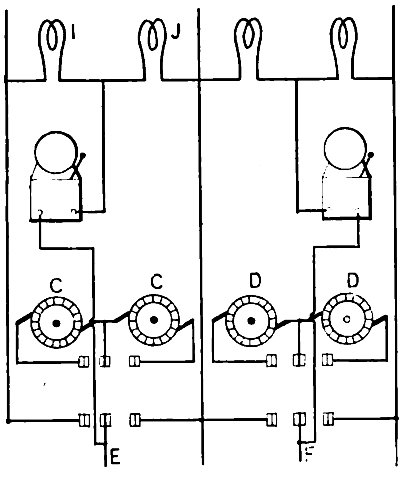


FIG. 6.—SIGNALING ARRANGEMENT.

A Frequency Meter.—J. Harden contributes to a recent issue of the "Elektrotechnischer Anzeiger" a description of a new frequency meter exhibited at Paris by Hartmann & Braun. The instrument will measure the frequency of any periodic current, whether alternating current or pulsating direct current, or the current from an induction coil. Its operation is independent of the wave form, and in outward appearance it resembles an ammeter or voltmeter. It has a scale for frequencies from 80 to 115, and tuned to the intervals of these numbers are 36 steel springs. A broad arm, on the axis of which is an alternating current magnet system, is turned around the scale by means of a button. When it comes opposite to the steel spring tuned to the frequency of the current under investigation the spring vibrates, emitting a tone which is readily detected. The frequency is read directly from the scale.

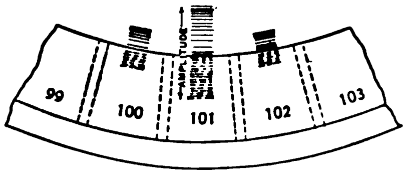


FIG. 7.—FREQUENCY METER SCALE.

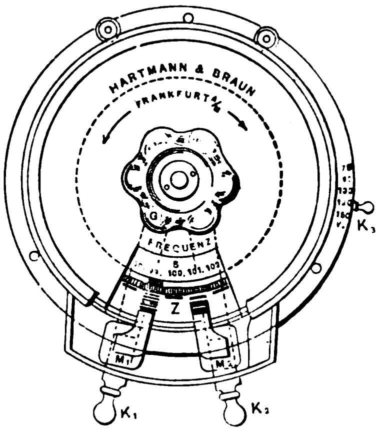


FIG. 8.—FREQUENCY METER.

Current Intensity of Lightning Flashes.— Some time ago, F. Pockels succeeded in showing that the remanent magnetism produced in basalt by a magnetic field depends only upon the maximum intensity of the latter, regardless of the length of time during which that maximum intensity might prevail. This fact, according to the "Physikalische Zeitschrift," he uses to determine the current intensity of lightning flashes. A rod of basalt is placed near a lightning conductor in such a position that the circular lines of magnetic force produced by a discharge would approximately pass through the length of the rod. The maximum intensity of the discharge current is then calculated. Some experiments made by Chistoni in the Monte Cimone observatory in the Apennines yielded magnetizations indicating currents of 10,000 to 20,000 amperes. Another rod showed a feeble magnetization which the author attributes to the prevalent "St. Elmo's Fire."

Feed Water Heater.-A very effective type of feed-water heater lately put upon the market is described in a recent issue of the London "Mechanical Engineer." The apparatus is built under the patent of G. G. Green, and is known as the "Airedale" feed-water heater. The construction is clearly shown by Fig. 9. The special feature consists of a spiral deflector placed inside each tube, as shown in the illustration. By the aid of this deflector the steam passing through the tube is given a rotary motion which breaks up the current and sweeps from the surface the drops of condensed water which naturally collect on the interior of the tubes. This permits a much more rapid transfer of heat from the steam to the feed water, and it is claimed by the makers that a tube thus fitted shows an increase of efficiency of 25 per cent as compared with the plain tube. A test was made upon an actual heater designed with suffi-

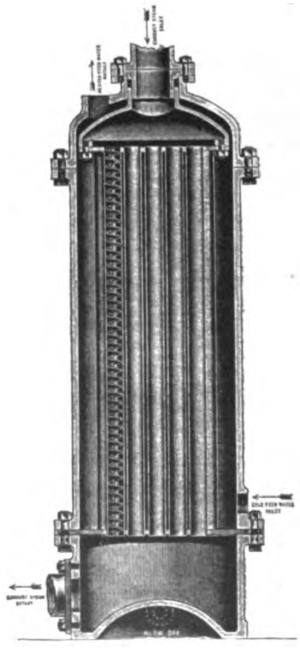


FIG. 9.—FEED WATER HEATER.

cient heating surface to heat 200 gallons per hour to about 200° Fahrenheit when working with ordinary tubes. The heater shell in both cases was filled with water at 70° Fahrenheit, and steam supplied through a ½-in. pipe. The temperature of the water in each case was as follows:

Without Deflectors.

Temperature at start	70° Fahr.
Temperature in 18½ minutes	180° Fahr.
Temperature in 21¼ minutes	190° Fahr.
Temperature in 23½ minutes	200° Fahr.

With Deflectors.

Temperature at start	70° Fahr.
Temperature in 2¼ minutes	180° Fahr.
Temperature in 3 minutes	190° Fahr.
Temperature in 5 minutes	200° Fahr.

The temperature was taken at the surface of the water in the shell, and all the steam was condensed in the tubes when the deflectors were used; whereas without deflectors a great portion of the steam passed through the tubes without in any way heating the water. Nothing is said concerning the extent to which the back pressure on the engine is increased.

Insulation Test.—A method for determining the relative insulation resistance of conductors is contributed by Dr. J. Rabinowicz to a recent issue of the "Elektrotechnische Zeitschrift." The connections are shown in Fig. 10, where G is a galvanometer; U, a switch; *x*, an insulated trough of water; K, a sample of the cable to be tested; E, a submerged copper plate; B, a battery having an e.m.f. of 20 volts; C, a condenser with a capacity of 1 microfarad, and M, a binding post. The current passing through the insulation of the cable is used to charge the condenser, C, the connection being as shown in the diagram. After a certain length of time the switch is thrown from 1 to 2, so that the condenser is discharged through the galvanometer. The insulation resistance of various cables may be compared by charging the condensers, as stated, for the same length of time for each cable and noting the deflection of the galvanometer on discharge. The cable giving the smallest deflection has the best insulation.

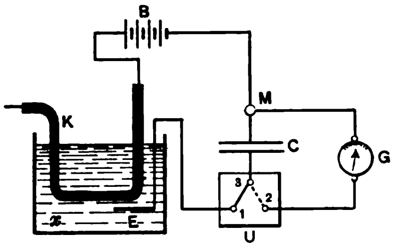


FIG. 10.—DIAGRAM OF CONNECTIONS.

Electric Arc Lamp Using Highly Refractory Electrodes.—Ewald Rasch contributes to the "Elektrotechnische Zeitschrift" an illustrated article in which he gives the principles of a new electric arc light using such highly refractory electrolytes as magnesia, oxides of thorium, zirconium, calcium, etc. In order to strike the arc the electrodes require to be heated as in the Nernst lamp; but the author claims the technical difficulties are not so great. The density at the ends of the electrodes is from 30 to 40 watts per square millimeter (0.00155 sq. in.), resulting in a very high temperature. Electrodes of magnesia, or oxide of zirconium give an arc of exceedingly white light, the gases formed also enhancing the luminosity. Electrodes of magnesia, calcium fluoride, oxide of chromium and oxide of nickel give a yellow light. Electrodes of 0.1 to 0.2 in. in diameter, yielding 600 to 1000 candle-power, give 3 to 4 candles per watt. When the arc is kept constant the ratio of candles per watt increases with increasing watts. The author found that at a pressure of 200 volts the specific luminosity in candles per watt, with constant arc length, increased up to 5.21 candles per watt and then decreases, the electrodes at that point becoming liquid; and Turmlirz, in his investigation of the mechanical equivalent of light, has shown that an ideal efficiency of 100 per cent corresponds to 5.21 candles per watt. The author claims that this light is considerably cheaper than the Welsbach incandescent gas light. In the accompanying diagram (Fig. 11) is given a comparison of the specific luminosity in candles per watt for different lamps.

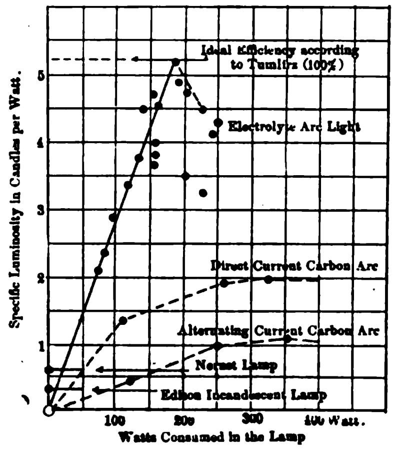


FIG. 11.—COMPARATIVE CURVES.

Alternating Frequency Indicator.—What is probably the simplest method yet devised for determining the periodicity of an alternating current is that of R. Wachsmuth, described in a recent number of the "Annalen der Physik." Clamped in a vise (Fig. 12) is a piece of watch spring, to which is fastened, by means of a bit of wax, a small square piece of white paper. When this is illuminated by a source of light fed by an alternating current, and caused to vibrate, it will appear to remain still when the frequency of the current equals the frequency of vibration of the spring. The latter may be calculated by the formula, N = 7.92 × the thickness in millimeters ÷ the square of the length in centimeters; but in practice a graduation may be easily marked on the spring itself. A small correction must be added for the paper in case of light springs. The method is applicable for frequencies as high as 150 per second, beyond which the springs become too stiff.

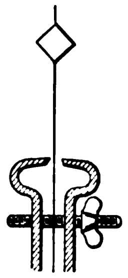


FIG. 12.

New Railway Conduit.—A recent issue of the London "Electrical Review" contains a description of a new slotted conduit for electric railways, the claims for which are that it can be rapidly laid, easily drained and cleaned, and a high insulation maintained, while the initial cost is comparatively low. Fig. 13 is a section through the conduit showing the mounting of the conductors. The sides of the conduit and slot are formed by pairs of specially-designed rolled steel Z-shaped sections of suitable length, separated at the ends, and bolted every 6 ft. to iron sleepers set in a concrete bed. The rails rest on the raised portion of the bed and are securely bolted to the iron sleepers and fastened to the sides of the conduit by tie bars. Interposed between and bolted to the ends of each pair of Z-shaped sections are iron frames which form the sides of the conduit between the sections. Iron doors are hinged to these frames, the opening of which gives free access to the conduit for cleaning, repairing, etc. The insulator holders are bolted to the Z-shaped sections within reach of the access doors, and are provided with grooves lined with suitable packing to carry and protect the insulators, which extend above and below the conductors and on both sides of the holders, to protect the back from dust and moisture and thereby maintain a high insulation. The feeder cables may be connected to the conductors under the access doors. The conduit only requires a maximum excavation of 18 ins.

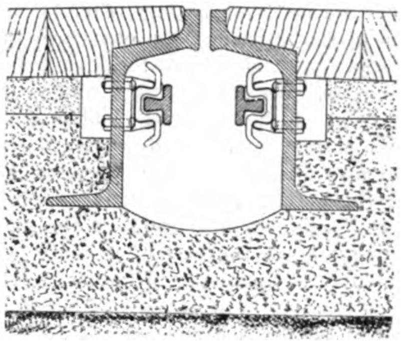


FIG. 13.—RAILWAY CONDUIT.

Testing Cells and Batteries in the Royal Navy.—According to the London "Electrical Review," two classes of cells are used in the British Navy, one having very high internal resistance, used for testing, and another used for performing ordinary work. The single-test cell is a Minotto, or modified form of Daniell, consisting of a cylindrical vulcanite container, in the bottom of which is placed a copper cup containing crystals of sulphate of copper. A piece of thick flannel or "fearnought" is placed on top of this, then a thick layer of fine sawdust, another disc of fearnought, and on this a zinc slab. An insulated wire passes up from the copper cup and forms the positive pole. The negative pole is formed by a wire leading from the zinc. The battery as supplied may be stowed away until required for use. The "fearnought"

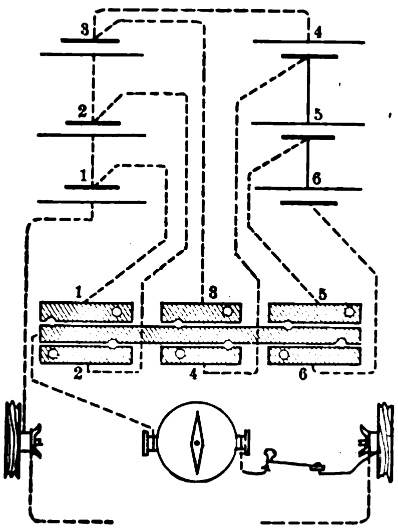


FIG. 14.—TESTING OUTFIT.

and sawdust are then soaked in fresh water, and the battery is put on short circuit for half an hour, after which it is ready for use.

The six-cell test battery, Fig. 14, consists of six Minotto cells, contained in a wooden box, and is used for high insulation tests. Besides having a hinged top, the front of the box opens outward and forms a tray, upon which is fixed a 1000-ohm astatic galvanometer, a spring key, and the main terminals. The system of brass blocks, which is fixed on the partition that keeps the battery in place, consists of one long strip of brass, having on either side of it three smaller strips, each of which is connected to the negative pole of its own cell. The long strip is connected with the galvanometer, and the negative pole of any cell can be brought into connection with it by means of a brass plug, thus putting from one to six cells into the circuit.

Mica Lagging for Steam Boilers and Pipes.—An illustrated article on the use of mica as a lagging for steam boilers and pipes, embodying excerpts from the experiments of Prof. Capper and R. Atkinson, is printed in a recent number of London "Engineering." In his experiments with four different kinds of well-known non-conducting compositions, Prof. Capper found that the steam condensed per square foot of cooling surface per hour for the different compositions was as follows:

	Thickness, inches.	Lbs.	Per Cent.
Bare pipe	....	1.516	100
A	1.6	.420	27.7
B	1.25	.399	26.3
C	1.4	.208	13.7
Mica	1.6	.177	11.67

The mica lagging is made up in flat and curved mattresses, enclosed between covers of wire netting sewn with wire. For small pipes it is molded to form and enclosed with textile covers. Minute flakes of mica are laid in parallel planes, transversely to the direction of flow of the heat, without any cement or adhesive to connect them together. The heat, therefore, on emerging from one flake has to cross an air space to enter the next flake. Here it encounters the surface resistance which is always found when heat travels from a gas to a solid, and then passes through the mica, which is a very poor conductor, to find a second surface resistance at its posterior face. The flow of heat is consequently very slow. The following table gives the results of a series of tests by R. Atkinson of the Canadian Pacific Railway. In these, tanks about 14 ins. cube were filled with water, which was then boiled and afterward allowed to cool down, the rate of cooling being noted. In one case the tank was bare, and in the other cases lagged with (1) asbestos compound, (2) magnesia blocks, (3) wood lagging and air space, (4) asbestos and wood, and (5) mica.

	Loss in Five Hours.	Temperature at end of Fifth Hour.	Mean Temp. during Fifth Hour.	Difference between Tank and Atmosphere.	Loss in Fifth Hour.	Loss in Fifth Hour per Deg. of Difference of Temp.
Bare tank	84	128	183½	55½	11	.198
Asbestos compound	53	159	163½	85½	9	.105
Magnesia bl'ks	33¾	178¼	181¾	103¾	7	.0674
Wood lagging and air space	33¾	178¼	181¾	103¾	7	.0674
Asbestos and wood	30	181	185	107	6	.056
Mica	20	192	194½	116½	5	.0428

Some Recent Electrical Patents

Revolving-Field Magnet Structure.—With a view to providing a field magnet for generators of the revolving-field type which shall be adapted for rotation at high speeds and simple in construction, B. G. Lamme has patented the structure shown by Fig. 1. The body portion of the field magnet is built up of a plurality of sections, five of these being shown in the lower drawing and numbers from 1 to 5. These sections have progressively smaller bores, the shaft having a series of shoulders at intervals a trifle less than the axial width of the magnet sections so as to allow the sections to be tightly compressed. All of the sections, of course, have the same number of polar projections, and a common polar cap or pole-piece, 12, is bolted to all of the sections. Ventilating apertures, 8, are provided through the sections, which communicate with radial ventilating slots, 7. The field magnet poles are provided with ventilating grooves, 9, allowing a circulation of air within the field coils. Patent No. 668,194.

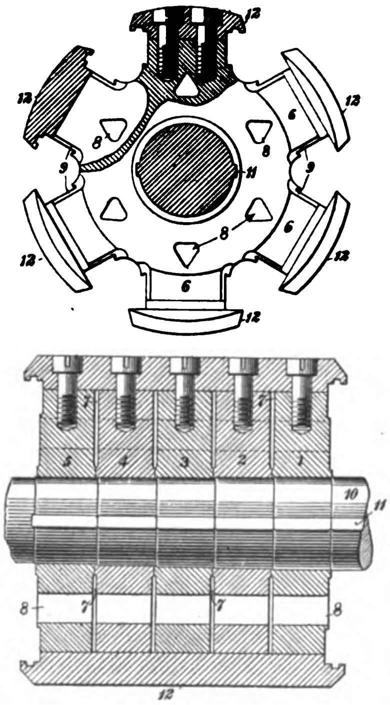


FIG. 1.—REVOLVING FIELD MAGNET STRUCTURE.

Variable-Speed Motor.—The appreciation of the utility of the electric motor for driving machine tools has developed a demand for an economical method of varying the speed of such motors, which has led to the production of various devices for this purpose. One of these, which controls the speed by varying the cross-section, and consequently the strength, of the field magnet, has been patented by Frederic A. Johnson. Mr. Johnson's method is illustrated by Fig. 2. The upper field magnet core is hollow and contains a plug, F, of magnetic material which may be drawn upward by means of the screw bolt, G, and a hand wheel, H, the hub of which is threaded to fit the screw-thread on the bolt. The plug, F, is prevented from turning by any suitable means, such as a groove in its side and a pin in the stationary part of the field magnet. The hollow cap, E, merely serves to hold the stationary portion of the field magnet core in position and has nothing to do with the regulation of speed. As the plug, F, is drawn up-

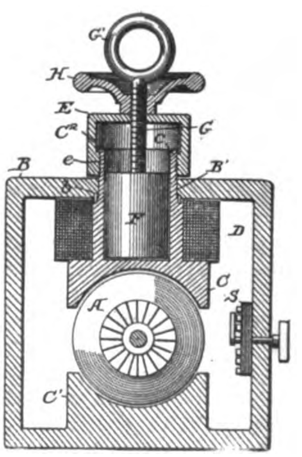


FIG. 2.—VARIABLE-SPEED MOTOR.

ward the magnetic reluctance of the circuit is increased and the flux is therefore decreased, resulting in an increase in the speed of the armature. Patent No. 666,315.

Protector for Incandescent Sign Lamps.—A well-known difficulty in the use of incandescent lamps for out-door signs is that of protecting the socket and base of the lamp from the weather. So important is this difficulty that special weather-proof lamp sockets and bases have been devised for this class of service. A method by which the ordinary wall socket and lamp may be used for sign work has been patented by E. Eckl, and is illustrated by Fig. 3. It consists of mounting the socket, B, on a base board, and providing an enclosing face plate, D, secured to the board by means of cleats, C, and having holes, E, into the mouth of each of which a socket projects; an annular cap or mantle, G, is screwed to the face plate and encloses the joint between the lamp base and the socket. The mouth of the mantle is flared outward so as to provide a channel, F, which prevents moisture from trickling down the inclined surface of the upper side on to the lamp. Patent No. 668,630.

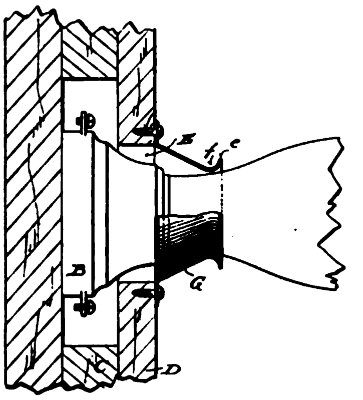


FIG. 3.—INCANDESCENT LAMP PROTECTOR.

Reserve-Fuse Box.—Fig. 4 shows a reserve-fuse box which has been patented by J. F. Lyons. The circuit terminals are attached to the plates, 2 and 3, and the circuit is completed normally by means of the fuse, 8. An auxiliary fuse, 18, is mounted on a pivoted non-conducting arm between two conducting plates, 13 and 16. This arm is normally held up in the position shown by the prop, 22, resting on the fuse, 8. When the latter blows, it is obvious that the prop, 22, will fall, allowing the arm, 11, to be thrown downward by means of the retractile spring at its rear end. The bifurcated clip, 13, straddles a pin, 20, on one of the main terminal plates, and puts the fuse, 18, in circuit between the two plates. Patent No. 668,293.

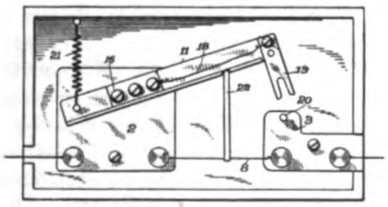


FIG. 4.—RESERVE FUSE BOX.

Wireless Telegraph Receiver.—Mr. Guglielmo Marconi, whose work is now too well known to require any detailed mention, has patented the form of wireless telegraph receiver illustrated diagrammatically by Fig. 5. In the drawing, A is the vertical conductor which is connected to one end of the primary, j^1, of an induction coil, the other end of the primary being grounded in the usual manner. The feature of the patent is in the arrangement of the secondary, j^2, winding of the induction coil. This winding is divided into two sections, one end of each section being connected to the coherer, T, and the other end being connected to the plates of a condenser, j^3. The layers of each of the secondary windings are tapered from the core out; that is to say, the first layer consists of 77 turns of wire, the second layer of 49 turns, the third of 46 turns, the fourth of 43 turns, the fifth of 40 turns, and so on until the last layer contains only three turns. A longitudinal cross-section of the coils, therefore, would show a triangular outline for each division of the secondary winding. C^1 and C^2 are choke coils, the function of which is to prevent the oscillations generated in the secondary winding of the induction coil from entering the battery circuit and weakening their effect on the coherer, T. Patent No. 668,315.

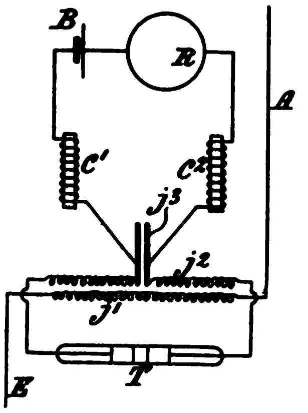


FIG. 5.—WIRELESS TELEGRAPH RECEIVER.

Controller.—It is frequently the case in street railway practice that the motors driving the car are heavily overloaded and the progress of the car made spasmodic by moving the controller handle too rapidly from the "off" position to one of the running positions. Fig. 6 illustrates a simple locking mechanism devised by Emmett W. Stull for the purpose of preventing the motorman from moving the controller too rapidly in a forward direction. On the controller spindle, B, is mounted a ratchet wheel, and on the backboard of the controller is pivoted a lever, F, carrying at its outer end a pawl, *f*, which is adapted to engage with the ratchet wheel when drawn inward toward the controller spindle. Beneath the ratchet wheel is provided a magnet coil around the controller spindle and connected in series with the motor circuit. This coil obviously magnetizes the controller spindle, the degree of magnetization varying with the amount of current flowing. The arrangement is such that when the current exceeds a predetermined limit the ratchet wheel, which is of iron, attracts the lever, F, which is also of iron, and thus draws the pawl, *f*, which is of non-magnetic material, into engagement with one of the ratchet teeth. A spring, K, is provided to oppose the magnetic attraction referred to. This spring is adjustable in order to predetermine the current flow at which the pawl will be drawn into engagement with the ratchet. The object in making the pawl, *f*, of non-magnetic material is to prevent it from being held in contact with the ratchet by residual magnetism. The inventor states that the coil used to magnetize the controller spindle would preferably be identical with the coil of the blow-out magnet. Patent No. 662,038.

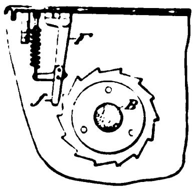


FIG. 6.

System of Electrical Distribution.—In electric railway systems where storage batteries are employed to smooth out violent fluctuations in the load, and in which the batteries are kept "floating" on the system, being charged during light-load periods and discharged during the heavy-load periods, it has been ordinarily the custom to connect the battery directly across the bus-bars in series with a booster; the function of the booster being to automatically regulate the charging and discharging of the battery. It is also customary in some other classes of service where plain shunt-wound dynamos are used, to connect a storage battery across the bus-bars for the purpose of taking care of load peaks, and permitting the use of generators the maximum output of which is determined by the average load instead of the maximum. In the latter case it has frequently been found that during the period of excessive load the dynamos would fail to take their share of the total load, and thereby cause the battery to be seriously overworked. Fig. 7 herewith illustrates diagrammatically a method proposed by Henry R. Kent for simplifying the general arrangement of storage batteries used for the purposes described and improving their operation. The generators are compound-wound machines connected up in the usual manner,

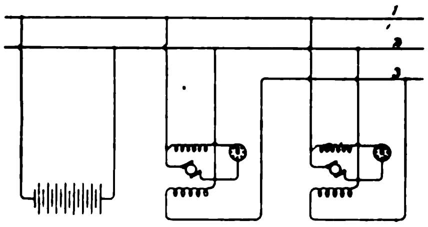


FIG. 7.—STORAGE BATTERY ARRANGEMENT.

but the battery, instead of being connected across the line bus-bars, 1 and 3, is connected between the line bus-bar, 1, and the equalizer bus-bar, 2. The effect of this arrangement is to put the battery in parallel with the armatures only, so that both the current from the battery and that supplied by the armatures pass through the series windings of the generators. It is obvious that any tendency to overload the battery will strengthen the field magnets of the generators and compel them to take a larger share of the load. Patent No. 663,659.

Steam Engine Efficiency.

To the Editor, American Electrician;

Sir:—In my article on "Steam Engine Efficiency," published in the March number of your paper I used the simple and well-known formula of the isothermal, or Mariotte, expansion curve, as the basis of comparison, not because it is simpler and hence more easily used by practical engineers, but because I believe it to be nearer correct than other formulas. On page 742 of Kent's "Mechanical Engineers' Pocket-Book" you will find the subject briefly alluded to and different authorities quoted, and perhaps I can justify my practice by the authorities there given.

Quoting the previous formula for better reference, the work in foot-pounds that should be done by 12 lbs. of steam of 150 lbs. boiler pressure, expanding 30 times, and exhausting into a condenser of 1 lb. pressure is

$$W = 144 \left[\frac{P\ (1 + \text{hyp. log } R)}{R} - p \right] R\,C\,S$$

when

$P =$ absolute initial pressure $= 165$ lbs.
$p =$ absolute condenser pressure $= 1$ lb.
$R =$ number of expansions $= 30$.
$C =$ cubic feet per pound of steam $= 2.72$.
$S =$ pounds of steam used per I. H. P. per hour $= 12$ lbs.

Making the substitutions, the result is 3,271,312 foot-pounds. As a horse-power = 1,980,000 foot-pounds per hour, the efficiency of the engine as a converter of available energy would be:

$$\frac{1{,}980{,}000 \times 100}{3{,}271{,}312} = 60.5 \text{ per cent.}$$

It is suggested by you that the adiabatic expansion curve should be used, but let us see what that would give us. Quoting the formula for this curve as given by you we have:

$$W = 144 \left[\frac{10\ P}{R} - \frac{9\ P}{R^{1.111}} - p \right] R\,C\,S,$$

and making the proper substitutions the result is 2,829,400 foot-pounds, and the efficiency is $\frac{1{,}980{,}000 \times 100}{2{,}829{,}400} = 70$ per cent.

The formula, $\frac{254{,}500\ (461 + T)}{H\ S\ (T - t)} = \text{Eff.},$ which was proposed by you is a purely theoretical one; it ignores the number of expansions entirely, and yet the engine designer is constantly compelled to limit cylinder proportions by practical considerations. In your formula,

$T =$ temperature of admitted steam $= 365.6$.
$t =$ temperature of condenser $= 102$.
$H =$ total heat of steam of 165 lbs. abs. pressure above $32° = 1193.5$.
$S =$ actual steam used per I. H. P. per hour $= 12$ lbs.

The value of H, however, should be the total heat of the steam minus the heat of the water at condenser temperature. Giving it this value and substituting the other values in your formula gives an efficiency of 59.2 per cent, instead of 55.7 per cent, as found by you. It is a mere accidental coincidence of figures that your result agrees so nearly with mine.

An engineer should be able to ascertain the efficiency of his engine under existing circumstances. He has found from the indicator cards the horse-power, and the same cards show the point of cut-off. Assuming a compound engine with cylinder proportions of 1 to 4.25, and a cut-off in the first cylinder of .25 or 4 expansions in the first cylinder, there is a total of 17 expansions, with an initial boiler pressure of say 150 lbs. Assume further that the condenser pressure = 2.20 lbs. absolute, and that careful measurements of feed water and calculations of power had shown that he was using 15 lbs. of steam per I. H. P. per hour. This is as much definite data as is generally available to a busy stationary engineer. He would like to know the efficiency of this engine. Applying the formula I have given and making proper substitutions we have:

$$W = 144 \left[\frac{165\,(1 + 2.8332)}{17} - 2.20 \right] \times 17 \times 2.72 \times 15 = 3{,}495{,}746 \text{ foot-pounds,}$$

and the efficiency would be $\frac{1{,}980{,}000 \times 100}{3{,}495{,}746} = 57$ per cent nearly.

This teaches him that 43 per cent of the steam supplied to the engine does no useful work. The larger part is condensed in the cylinder, considerable leaks through the piston or valves into the condenser, a small part is condensed by radiating its heat into the atmosphere, and some is wasted by the clearance spaces in the cylinders and receiver connections. Were all of these losses eliminated an efficiency of 100 per cent would be realized. It is true that this is impossible in practice, and it is also impossible to realize 100 per cent mechanical efficiency, but if we find the latter to be only 75 per cent or 80 per cent we search for the cause and apply a remedy, for a well-constructed steam engine ought to have a mechanical efficiency of 88 per cent to 93 per cent. It is in order to give the practical engineer a clear conception of the losses in his engine which come within the domain of man to reduce or to bring by skill to nearly a 100 per cent standard of efficiency that I make use of the formula I have given.

A. F. Nagle.

Montclair, N. J.

NEW BOOKS.

The Copper Handbook. By Horace J. Stevens. Houghton, Michigan: Horace J. Stevens. Paper; 328 pages, 5¾ x 8¾ ins. Price, $1.

This is a very comprehensive discussion of the copper industry generally, and begins with a historical review of the Lake Superior copper region, including a political history of the Upper Peninsula, and the discovery of copper. The second section of the book is devoted to miscellaneous information, including a sketch of the Michigan College of Mines. This is followed by a section outlining the geological characteristics of the country, after which is given a vast amount of statistical information, mostly tabular, relating to copper production, dividends paid by various mines, capitalization of mining companies, American copper production and exports, English copper statistics, the world's copper production, etc., etc. The final section of the book is descriptive of defunct and active copper mining companies. The book should be of great value to anyone interested in the copper mining industry.

The Progress of Invention in the Nineteenth Century. By Edward W. Byrn, A. M. New York: Munn & Co. Buckram; 476 pages, 6½ x 9½ ins.; 306 illustrations. Price, $3. Half red morocco, with gilt top, $4.

As its title would indicate, the scope of this book is unusually extensive; consequently it could not be made thorough within the limits of a single volume. As the author states in the preface, "it is simply a cursory view of the century in the field of invention, intended to present the broader bird's-eye view of progress achieved." The "bird's-eye view" is a very interesting one for the most part, but it is marred by inaccuracies and important omissions in spots. The description of the dynamo credits the commutator and brushes with "gathering up all the impulses of the same polarity and conducting them away by one brush and gathering those of opposite polarity and conducting them away by another brush," which is a crude way of stating it. Polyphase work is dismissed with the slovenly statement that "an important development * * * is to be found in what is known as the polyphase multiphase, or rotating current, pioneer patents for which were granted to Tesla May 1, 1888." A most ridiculous statement is found on page 71, to-wit: "Although the alternating current is used for arc light, only continuous current can be used for the incandescent lights." In the chapter relating to steam engineering the author falls into the common error of crediting Stephenson with the invention of the reversing link valve motion and Seguin with the multitubular boiler, when it is well known that one of Stephenson's pattern-makers devised the link and Nathan Read the tubular boiler. Aside from inaccuracies of the kind enumerated, however, the book makes very interesting reading.

NOTES.

The Milwaukee Industrial Exposition.—The Board of Directors of the Milwaukee Industrial Exposition are seriously considering a suggestion to make this year's exposition almost entirely electrical.

A Correction.—In the description of a 75-light dynamo which was published in the January number it was stated that the armature core should have 40 slots. This was a misprint; the correct number of slots is 41.

Summer School for Apprentices and Artisans. — The University of Wisconsin, Madison, Wis., has made quite a departure in educational work in the shape of a summer school for machinists, carpenters, engine tenders, shop foremen, superintendents and other practical workers. The session begins July 1 and ends August 9. Complete information concerning this course may be obtained from Mr. J. B. Johnson, Dean of the College of Engineering, at the University.

United Electrical Contractors' Association.—At the annual meeting of the United Electrical Contractors' Association of New York State, held in January of the present year, it was decided to issue a call for a meeting at Buffalo on July 17 for the purpose of forming a National Electrical Contractors' Association. This meeting will be held at the Builders' Exchange Building, Buffalo, at 10 A. M., on the date mentioned. Further information may be had from the secretary of the association, W. H. Morton, 31 Catharine Street, Utica, N. Y.

Southwestern Gas, Electric & Street Railway Association.—The third annual meeting of this association will be held at Houston, Tex., on April 19-22. The headquarters will be at the Rice Hotel. The papers scheduled for this meeting are as follows: "Municipal Ownership vs. Private Corporations," by T. B. Miller; "Association Between Meetings," by C. A. Newning; "Station Work," by Geo. Cushman; "Street Railways of Texas," by F. E. Scovill; "Inspection," by W. S. Rathell; "Cheap Fuel and How to Use it Economically," by L. T. Fuller; and "Water Power for Small Plants," by F. R. Starr.

Water Power Development in Nebraska.—A company has been organized for the purpose of developing an extensive water-power plant on the Niobrara River, Nebraska. A dam about 2000 ft. long and a canal about 7 miles long will be built. It is expected to realize 1500 to 2000 horse-power, which will be distributed electrically throughout the adjacent territory. A 35-mile electric railway in Knox and Boyd Counties is contemplated, which will be supplied with power from the proposed hydraulic plant. Mr. Arnold C. Koenig, of Grand Island, Neb., has been appointed chief engineer for the undertaking.

Electrical Development in the West Indies.—The British Colonial Office on the island of Trinidad has granted a charter to the Trinidad Electric Company, which is composed of Montreal capitalists, for the construction of an electric railway line and lighting plant in the city of Port of Spain, the capital of the island. The Trinidad Electric Company obtained control of the existing mule railway lines and lighting plant in Port of Spain some months ago, and the present charter enables it to convert the railway lines into electric trolley lines, and to extend the electric lighting plant to all parts of the city and its suburbs.

The Reflection of Light.—Incandescent lamps and other sources of illumination are frequently used under great disadvantage by reason of unfavorable wall surfaces, the colors of which are such as to absorb the light instead of reflecting it. In a recent issue of a German paper there was given a table showing the percentage of light reflected by surfaces of various colors. It will be advantageous for central station men to use this table as an aid in making installations of incandescent lamps; the table is reprinted below:

Surface.	Per cent.
Black velvet	0.4
Black cloth	1.2
Black paper	4.5
Dark blue	6.5
Dark green	10.1
Bright red	16.2
Deep yellow	20.0
Pale blue	30.0
Pale yellow	40.0
Pale green	46.5
Pale orange	54.8
White	70.0
Mirror surface	92.3

These figures do not take into consideration actinic or chemical effects, but only the optic effect.

A Short But Heavy Duty Transmission Line.—The line which conducts current to the electrolytic plant of the Boston & Montana Smelter at Great Falls, Mont., from the power-house (hydraulic) is probably the only one of its kind in the world. Each conductor of the circuit consists of bars of copper 2 ins. by 12 ins., with the ends lapped and bolted together. The cross-sectional area of each conductor is therefore 24 sq. ins. The bars rest on glass blocks on top of a wooden trestle work built for this line. It is found that 10,000 amperes heats the conductor comfortably warm in cool weather. As the dynamos that supply this line are run by water wheels which have no governors on account of the load being constant, it is necessary to provide against a runaway in case the circuit should accidentally be broken. For this purpose there is an electro-magnetic relay connected in the main circuit, and so arranged that if the current falls off, a switch is instantly closed, putting on an artificial load in place of that accidentally cut out. The artificial load consists of common iron steam pipe filled with circulating water from the river and used as dead resistance.

The National Standardization Bureau.—The bill to establish a National Bureau of Standards passed the U. S. House of Representatives on March 2 and the Senate on March 3. Several amendments were made, the effect of which will reduce the items of appropriations, but these will not materially affect the establishment or the work of the bureau.

A Railway Consolidation in California.—The Oakland Railway Company, which operates 24 miles of railway, has been sold to the Oakland Transit Company, formerly operating 81¼ miles of railway, so that the latter company now operates 105¼ miles of railway. With one exception, the Oakland Transit Company controls all the street railway lines in Alameda, Berkeley and Oakland.

The Steam Engine and its Competitors.—In an extremely interesting paper read at the February meeting of the American Institute of Electrical Engineers, Mr. W. J. Hammer devoted considerable space to a discussion of the steam engine and rival prime movers. This section of Mr. Hammer's paper included a letter from Dr. R. H. Thurston which contained the statement that the best work so far done by steam and gas engines is practically on a par; each has delivered a net horse-power with a consumption equivalent to about 1 lb. of good coal. Dr. Thurston also expressed the opinion that the steam engine has attained so nearly its limit that further progress under commercial conditions would seem likely to be very slow and to be dependent mainly upon the possibility of extending the thermodynamic range of working temperatures. Improvements in the direction of higher pressures and superheated steam should, he said, permit an increase in efficiency by something like 50 per cent, which would mean a decrease in fuel consumption of about 25 per cent. On the other hand, there is much larger opportunity to reduce the wastes which now characterize the gas engine than to extinguish those affecting the steam engine. The gas engine, he said, had come to be a formidable rival of the steam engine and is gaining upon it rapidly. Mr. Hammer described several large gas engines of European manufacture, among them the Cockerill engine for utilizing blast-furnace gases, which was described in our issue of August, 1900. Mr. Hammer also described an electrical plant in Upper Silesia driven by Otto-Deutz gas engines of 200 and 300 horse-power, the smaller engines being direct-coupled to direct-current dynamos, and the larger ones to alternating-current dynamos. The circuit load consisted of several thousand incandescent lamps and a number of motors. The experimental sulphur-dioxide engine at the Charlottenburg High School, which was referred to in this department of the April, 1900, number, was also described by Mr. Hammer, as well as the Parsons turbines at the Elberfeld three-phase alternating-current plant.

ESTABLISHED 1889.

American Electrician,

WITH WHICH IS INCORPORATED
Electrical Industries.

CECIL P. POOLE, Editor.

Published on the first of each month by the
American Electrician Company,
NEW YORK: 120 Liberty Street.
CHICAGO: Monadnock Block.
PHILADELPHIA: 929 Chestnut Street

JAMES H. MCGRAW, President.
A. E. CLIFFORD, Vice-President.
C. E. WHITTLESEY, Treasurer.
E. E. WOOD, Secretary.

Subscription, - $1.00 Per Year.
In the United States, Canada and Mexico.
FOREIGN COUNTRIES, $2.00.

NOTICE TO ADVERTISERS.

Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

IMPORTANT NOTICE.

Intending subscribers are warned not to place subscription orders with persons who cannot show written authority to take such subscriptions and make collections therefor, as the paper will not undertake to fill orders placed with alleged agents acting without such written authority.

Subscribers requesting a change of address should invariably furnish both the old and the new address.

Vol. XIII. APRIL, 1901. No. 4

The American Electrician has a larger paid subscription list than any other electrical journal in the world.

CONTENTS.

Alternating-Current Equipment of a Packing House.......... 149
Electrical Illumination and Fountains at the Pan-American Exposition.......... 154
Electromagnets and Solenoids.......... 155
Fan Motors for 1901.......... 158
Water Hammer.......... 172
Abstracts from Foreign Contemporaries 173
Some Recent Electrical Patents.......... 176
Steam Engine Efficiency, by A. F. Nagle 178
New Books.......... 178
Notes.......... 179
Editorial.......... 180
Design for a Direct-Current Fan Motor.. 182
Interior Wiring, by Charles E. Knox.... 184
Repairing and Connecting Up Commutators, by A. B. Weeks.......... 187
Water of Condensation, by C. W. Obert.. 187
Weak Fields and Grounded Armatures, by Frank Berry, Jr.......... 189
Common Battery Telephone Systems, by W. S. Henry.......... 189
Lessons in Practical Electricity.......... 190
Letters on Practical Subjects.......... 192
Electrical Catechism.......... 194
Electrical Diagrams.......... 195
Queries and Answers.......... 196
Transformers for the Manhattan Elevated Railway.......... 197
Test of a High-Speed Engine.......... 197
A Small Dynamo.......... 197
New Apparatus and Appliances.......... 198
Legal Notes.......... Adv. 39
Obituary.......... Adv. 39
Personals.......... Adv. 39
Trade Publications.......... Adv. 39
Business News.......... Adv. 40

Electrical Equipment in Industrial Plants.

The plants described in our leading article this month exemplify strongly both the advantages obtained by the electrical distribution of power in industrial plants and the flexibility of alternating currents as applied to a composite service. A number of small, inefficient and troublesome steam plants have been displaced by a single power generating plant easily attended and of high economy. Three separate classes of service are supplied from a single source, so that there is only the one class of generator to handle. This, of course, is not new practice, several isolated plants and many central stations being operated in this way; and judging from the rate of increase in the number of these plants, the convenience of operation would appear to overbalance the well-known disadvantages inherent in the use of induction motors.

One of the features of the St. Joseph plant is an elevator motor which is thrown on and off with the elevator, as in direct-current practice. In this case, however, the motor is thrown on, apparently, without any auxiliary resistance in circuit, the impressed e.m.f. being reduced from 220 volts to 140 volts by an ordinary transformer. The effect of this upon the busbar e.m.f. must be highly interesting, and a contemplation of this procedure naturally arouses doubts as to the advisability of saving the expense necessary for wound rotors with inserted resistances, when the saving entails such objectionable results as must follow from the practice described.

◆

The Heat Waste of a Gas Engine.

It is, of course, well known that the work indicated in a gas engine cylinder accounts for only about 20 per cent of the heat energy due to the combustion of the gas, and the utilization of some of the rejected heat units forms an interesting problem. Some designers have attempted to extend the range of expansion, with varying degrees of success; the Atkinson two-cycle engine is a notable example of effort in this direction. One of the most attractive plans for raising the economy, and one that would naturally occur to a speculative mind, is to utilize the heat in the jacket water and exhaust gases for some purpose such as supplying a heating system. This is obviously open to the objection that it is difficult to operate satisfactorily two systems different in character when one is entirely dependent upon the other. In due course of progressive reasoning, one reaches the suggestion that the discharged jacket water and exhaust gases be made to operate an auxiliary steam engine, either a totally separate machine or arranged to deliver power to the gas engine shaft and, therefore, regulated along with it. The heat in the exhaust gases would be used to evaporate as much of the jacket water as possible into steam to supply the auxiliary engine.

A rough investigation of a case based on results obtained in gas engine practice, however, seems to show that the saving obtainable, although appreciable, would not be so great as might at first be supposed. For example, a test of an Otto engine indicating 13 horse-power showed that 900 lbs. of jacket water passed through per hour and was raised in temperature from 64 to 110° Fahr. The exhaust gases had a temperature of 1210° Fahr., and the heat contained in them was rejected at the rate of about 66,000 B. T. U. an hour. Assuming that the temperature of these gases could be usefully reduced to 80° Fahr. by transmitting their heat to water through the medium of a vaporizer, there would be about 46,000 B. T. U. an hour available for evaporating water into steam for the auxiliary engine. Supposing that the steam pressure to be carried were 120 lbs. by gauge in order to admit of compounding, then our 46,000 heat units would evaporate about 42 lbs. of water an hour, the supply being taken from the delivered jacket water having a temperature of 110° Fahr. This quantity of steam would enable the auxiliary engine to develop about two horse-power, and increase the mechanical output of the fuel about 15 per cent. It might be that in larger sizes such a combination would figure out to better advantage, but it is doubtful if the gain in net power would justify the complication of the added parts and the expense of providing them, under existing conditions of practice.

◆

Alternations and Cycles.

Several correspondents appear to be confused as to the distinction between an alternation and a cycle. For purposes of application it would suffice to explain that two alternations make one cycle, but for the man who always (and commendably) desires to "know why," this explanation is unsatisfactory, notwithstanding its absolute accuracy. When an alternating current passes from its maximum strength in one direction to the same strength in the opposite direction it accomplishes one "alternation" or reversal;

then it goes back again to maximum strength in the first direction, passing through another alternation. When it has done this a complete "cycle" has been performed, because the current has come back to the condition in which it was at the beginning of the cycle and any further variation will be merely a repetition of what has already occurred. A cycle is a series of events or operations which occur or are performed over and over successively in the same order, hence the application of the name to the two reversals of current. A cycle is also called a "period" by some engineers; this appellation is used to a greater extent in Great Britain than in this country. The frequency of an alternating current when given in cycles is always the number of cycles per second; when stated in alternations, it is always the number of alternations per minute. Thus, the current in a 60-cycle circuit passes through 60 cycles per second, and is also said to make 7200 alternations, meaning 7200 reversals or half-cycles per minute. Similarly, "133 cycles" and "16,000 alternations" are synonymous terms.

Steam Engine Efficiency.

A discussion of steam engine efficiency might be indefinitely prolonged unless the parties to it could agree upon a close definition of the word "efficiency." Last month we gave expression to an opinion concerning Mr. Nagle's method of computing efficiency, published in the same number, and suggested what seemed to us a somewhat more accurate method. That Mr. Nagle does not agree will be evident from a perusal of his very interesting letter, printed elsewhere in the present number; that the real cause of disagreement is a discrepancy between the two conceptions of 100 per cent efficiency will be evident also. If 100 per cent efficiency be taken to mean the performance of the maximum work possible under conditions of isothermal (hyperbolic) expansion, then Mr. Nagle's method is correct. It is difficult to see, however, why hyperbolic expansion should be made the basis of efficiency, because an engine working with no losses in the cylinder could not possibly show hyperbolic expansion. Mr. Nagle himself states in his letter that if all the losses due to cylinder condensation, piston and valve leaks and clearance spaces could be eliminated, an efficiency of 100 per cent would be realized; now, under these very conditions the steam would expand adiabatically and the ideal curve obtained could not be a hyperbola. Consequently the hyperbolic formula is scarcely consistent with his own statement of what 100 per cent efficiency would be.

It was by no means intended to suggest last month that the adiabatic curve should be made the criterion of efficiency. We only stated that if any curve were to be taken it should be the adiabatic for the reason that if the cylinder were a non-conductor of heat the steam would expand adiabatically, and a non-conducting cylinder would certainly be an essential to the no-loss condition. However, no one knows accurately what the formula for adiabatic expansion is. The formula printed last month was based upon the adiabatic formula commonly quoted, but it has never been verified—naturally, since a non-conducting cylinder has yet to be made. As we pointed out before, it seems much simpler and more rational to ignore expansion curves and start from the available energy contained in the steam; then see how much of this is accounted for by work. This is what we suggested, and what we still consider the rational basis of efficiency. The admitted steam contains a certain number of heat units and the fraction $\frac{T - t}{461 + T}$ represents the proportion of these heat units that are available for work. If all of the heat units in the steam be represented by H, then the total heat available is $H \frac{T - t}{461 + T}$, regardless of expansions or anything else. If the exhaust steam does work in heating feed water after leaving the engine, that is a separate operation which raises the plant efficiency but has no effect upon the efficiency of the engine as a converter of energy because it alters neither the heat units delivered to the machine nor those thrown out in the exhaust.

When all is said and done, however, it really remains a matter of the definition of 100 per cent efficiency. The British Institution of Civil Engineers recommends that the performance of an engine be stated as economy in thermal units per minute per indicated horse-power, which is highly practical. The thermal units are taken as the total heat of the admitted steam minus the heat of its weight in water at exhaust temperature. For purposes of comparison, however, an ideal engine is made the standard, the performance of which is assumed to follow the Rankine cycle—feed water at exhaust temperature, admission up to cut-off at constant pressure, adiabatic expansion down to the back pressure, and exhaust at constant pressure corresponding with the lower temperature limit. Rankine's formula for work done by a cubic foot of steam expanding adiabatically against a back pressure, p, and exhausting at a pressure, p_e, modified to apply to a pound of steam, reads

$$W = 778 \left[T - t \left(1 + \text{hyp log} \frac{461 + T}{461 + t}\right) + \frac{T - t}{461 + T} L + R \left(p_e - p\right) \right]$$

in which L is the latent heat per pound of steam at admission and R the number of expansions. This would form a nice subject for study on a rainy Sunday afternoon. No less an authority than Prof. C. H. Peabody gives the efficiency of steam in an engine cylinder as the ratio of work done to the heat energy supplied, figuring the latter above exhaust temperature, and so it goes. As we remarked before, it all depends upon what is meant by efficiency.

A Useful Form of "Dead" Resistance.

Suggestions have been made by several persons to the effect that instead of wasting the energy commonly expended upon resistance coils in series with fan motors, electric bells, etc., it might be turned to account by using incandescent lamps for "dead" resistance. While the practicalness of these suggestions may be to a high degree problematical so far as motors and bells are concerned, there is no doubt that the resistance coils usually put in series with enclosed-arc lamps could in many cases be displaced electrically by incandescent lamps to good advantage. One 6.6-ampere arc lamp on a 110-115 volt circuit, for example, lacks about 35 volts of taking the full circuit e.m.f., and this voltage is therefore available for the incandescent lamp or lamps. A single lamp of about 64 candle-power would just fill the gap, and as this would permit an economy of 3.6 watts per candle the lamp should stand the fluctuations in impressed voltage reasonably well. The unsteadiness would probably unfit the light for reading purposes, but it could be utilized for general illumination. If memory serves, a few sporadic attempts have been made to employ incandescent lamps in this way, putting a parallel group of lamps of low candle-power in series with one arc. Nothing has been heard lately, however, concerning the results of these trials or as to any extension of the plan.

THE CONSTRUCTION OF A DIRECT-CURRENT FAN MOTOR.

The accompanying engravings illustrate a compact form of direct-current fan motor, the construction of which is easily within the ability of anyone at all experienced in the use of machine tools. The motor is of the bipolar ironclad type; the field magnet having the form and dimensions shown by Fig. 5. Fig. 2 is an axial cross-section of the motor frame taken vertically. It is intended that the magnet proper shall be of cast-steel set into a thin cast-iron shell, the front cap of which is integral with the shell, as indicated by Fig. 2; but if the builder should prefer, the entire structure may be made a single casting of steel. The first construction requires somewhat more machining, as it will be necessary to turn up the exterior of the field magnet and bore out the cast-iron shell so that the two will fit snugly together; but the result will be a very much better-looking machine than if the field magnet structure were wholly of cast-steel. There is only a single bearing, the shell of which is cast integral with the motor casing, as indicated in Fig. 2, and this is provided with a grease cup of the ordinary gravity-feeding type. A cross-section of the cup is included in Fig. 2, and a dimensioned drawing of it is given by Fig. 1.

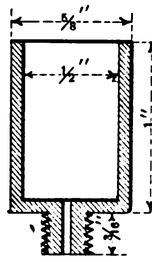


FIG. 1.

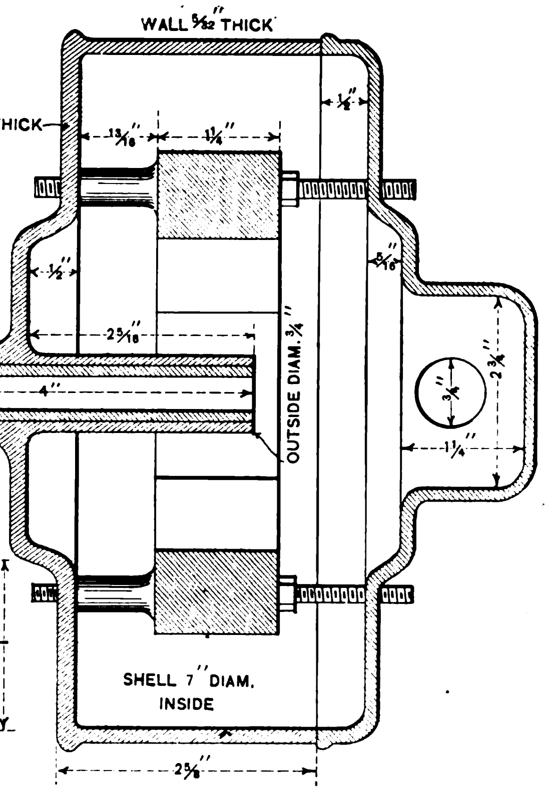


FIG. 2.—CROSS-SECTION OF MAGNET AND SHELL.

The rear cap of the motor case, a vertical cross-section of which is shown in Fig. 2, is detachable, and is provided with a recess extension near the center to accommodate the commutator. The brush-holders, which are of the ordinary tubular type, are mounted in insulating bushings in opposite sides of this extension. This end cap is intended to be of cast-iron no matter which way the field magnet is constructed. It is secured in place by means of nuts which thread on four machine screws that pass completely through the field magnet. These four screws also serve to secure the fan guard to the opposite side of the case, and in the event that the field magnet proper is made of cast-steel and the case of cast-iron, the same screws serve to hold the magnet in the case, as indicated in Fig. 2 and Fig. 3, which show this construction. The photograph shows the field magnet casing mounted on a trunnion pedestal, but of course the builder can use any form of mounting he may prefer. This is about as simple, however, as any that an amateur can construct that will provide both vertical and horizontal adjustment. The trunnion yoke, shown in Fig. 3, is a separate casting with a stem fitting into a hole in the pedestal, which enables the motor to be swung around about a vertical axis, while the trunnions provide for adjustment up and down about a horizontal axis.

The armature core is of the ordinary drum type provided with 12 holes for the winding, the holes being located so that the outer edges are 1/16 in. below the edge

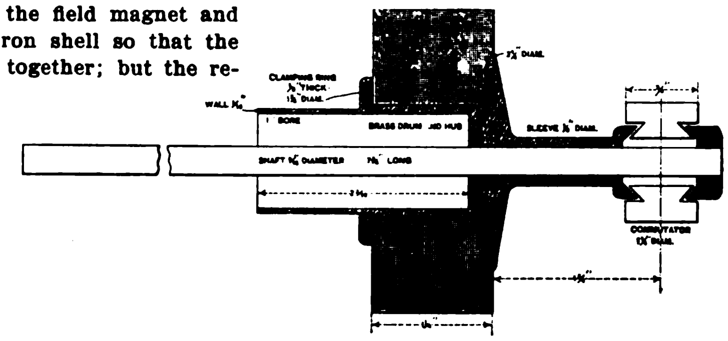


FIG. 4.—CROSS-SECTION OF ARMATURE CORE AND COMMUTATOR WITH SHAFT.

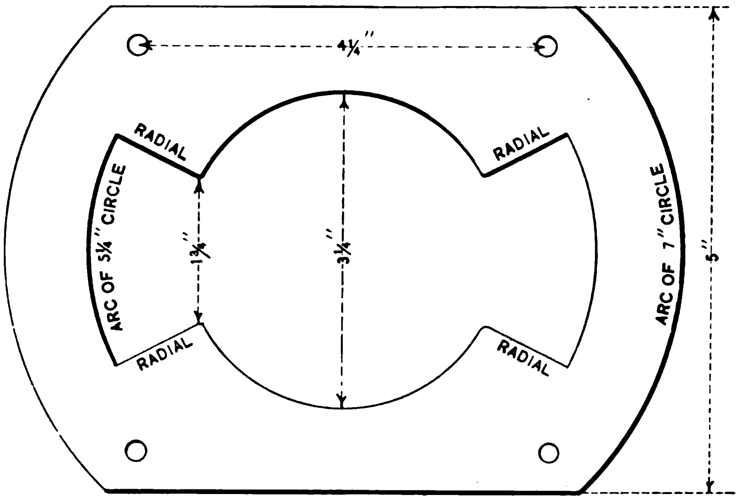


FIG. 5.—FACE VIEW OF FIELD MAGNET.

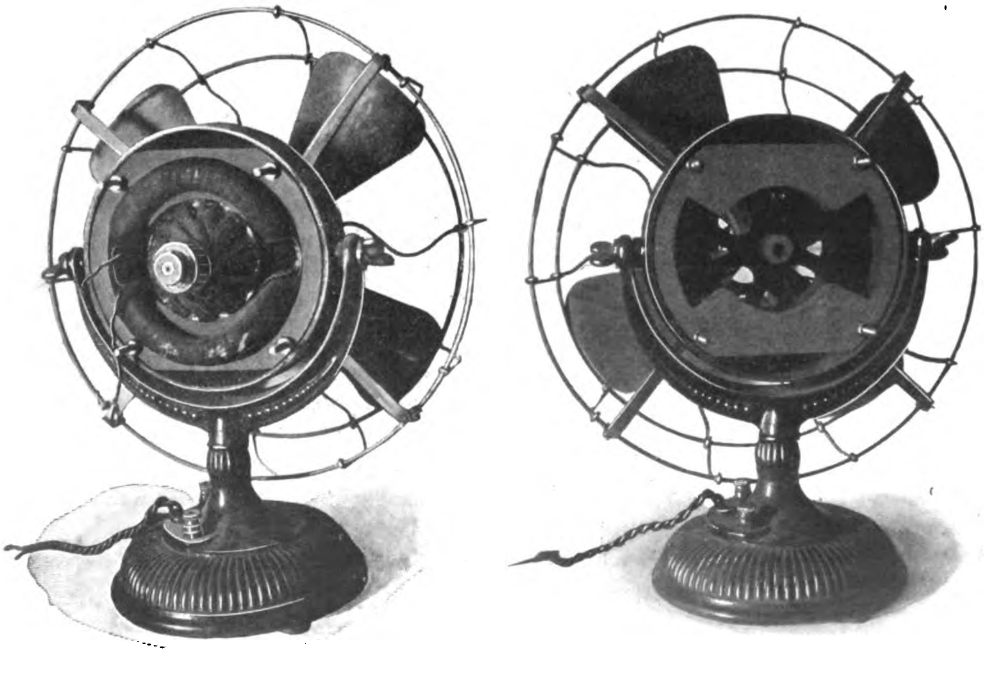


FIG. 3.—VIEW OF MOTOR WITH AND WITHOUT FIELD COILS AND ARMATURE.

of the armature core, as indicated in Fig. 7, which shows the condition of an armature disc before the core is assembled. After assembling the discs on the shaft the thin webs between the winding holes and the periphery of the disc must be cut away, preferably with a milling tool, but allowably with a hack-saw and file, leaving the discs as indicated by Fig. 8. The holes for the winding are ⅝ in. in diameter. Fig. 4 is a cross-section of the complete core with the shaft and commutator. The brass drum on which the core discs are mounted is open at the end opposite from the commutator to allow the bearing shell on the motor frame to project into the core. There is no bearing beyond the commutator. Fig. 6 is a cross-section of the brush-holder with its insulating bushing.

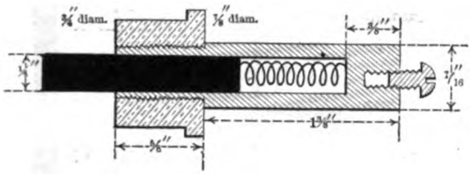


FIG. 6.—CROSS SECTION OF BRUSH HOLDER.

The armature winding consists of 12 coils of No. 33 double silk-covered magnet wire, each coil containing 185 turns. A winding diagram may be made by drawing an armature disc and numbering the slots successively. The winding should proceed as follows: First wind a coil in slots 1 and 6, twisting the terminals together lightly near slot 1. Then turn the armature core through half a revolution and wind a coil in slots 7 and 12, twisting the terminals together near slot 7. The next two coils should preferably come in slots 9 and 2, and 3 and 8; the next two in slots 5 and 10, and 11 and 4. This will complete half the armature winding. The seventh coil goes in slots 10 and 5 on top of the coil previously wound in those slots, but the terminals are twisted together at the opposite side of the coil near slot 10. The eighth coil goes in slots 4 and 11; the ninth coil goes in slots 2 and 9 with the terminals left near slot 2; the tenth coil goes in slots 8 and 3 with the terminals near slot 8; the eleventh coil goes in slots 12 and 7 with the terminals near slot 12; and the twelfth coil goes in slots 6 and 1 with the terminals near slot 6.

In winding the coils, care should be taken to preserve identification of the starting and finishing terminals of each coil. The best plan is to tie a knot in the starting terminals and then leave the finishing terminals straight. When all the coils are in place untwist the 12 pairs of terminals and connect the coils together as follows: Twist the finishing end from slot 1 to the starting end from slot 2; finishing end from slot 2 to starting end from slot 3, and so on all the way around the armature. Then carry the twisted terminals out to the commutator, the pair from slots 1 and 2 going to segment No. 1, and the pair from slots 2 and 3 going to segment No. 2, and the pair from slots 3 and 4 going to segment No. 3, and so on all the way around. The terminals of the coils cannot be pulled through straight out to the commutator but must be laid flat along the head of the armature winding and bound into place by means of strings as illustrated in Fig. 10, which was made from the photograph of the complete armature. This precaution is necessary in order to prevent the edge of the recess in the removable cap from chafing the leads running to the commutator.

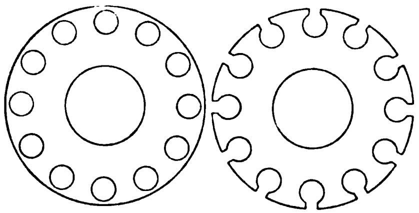


FIG. 7. FIG. 8.
ARMATURE DISCS.

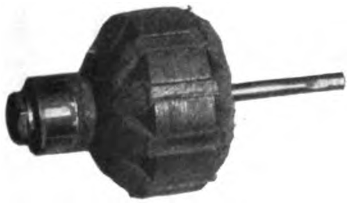


FIG. 10.—VIEW OF ARMATURE.

The commutator has 12 segments, and is preferably of the construction illustrated in Fig. 4, but the reader is strongly advised to purchase a commutator from any one of the various manufacturers rather than to attempt to construct it. The winding of the armature across the heads must be compressed until it measures not more than 2¾ ins. along the shaft. The field magnet winding consists of two coils of No. 25 single cotton-covered magnet wire wound into the ordinary rectangular outline and then taped and bent to the form shown in Fig. 11. Each coil must contain 30 layers of wire and each layer must have 44 turns, making 1320 turns per coil.

The machine is designed for two speeds; with the field magnet coils connected in parallel it will run at the maximum speed, and with the coils connected in series it will run at the lower speed. The magnet coils are connected in series with the armature irrespective of their relation with each other. A switch should be provided in the base of the motor for the purpose of cutting the fan in and out of circuit, and changing the relation between the field coil connections. A diagram of the switch is shown by Fig. 9. The details of its construction may be worked out to suit the individual ideas of the builder, the only essential features being that it shall be mounted on a non-combustible base, preferably of slate or porcelain, with the metal parts so disposed that they cannot possibly come in contact with the pedestal base. The connections between the field magnet coils and the switch in the base are preferably established by means of ordinary lamp cords led through holes in the end cap and in the pedestal base. Each of these holes should be insulated with a substantial fiber bushing. A double-pole snap switch should be inserted between the motor and the supply circuit.

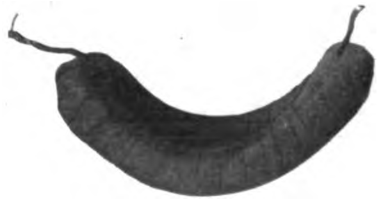


FIG. 11.—FIELD COIL.

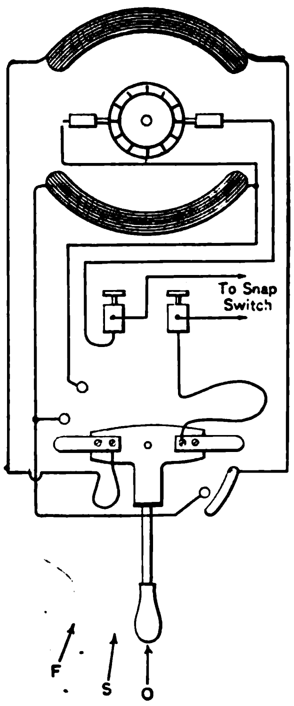


FIG. 9.—DIAGRAM OF SWITCH CONNECTIONS.

Fig. 12 shows the complete motor with the fan and guard, but the reader is advised to purchase both fan and guard from any dealer in electrical supplies; the design of a propeller fan is not a sufficiently simple matter to justify an amateur in attempting it, and the same is true of the fan guard, although to a lesser degree.

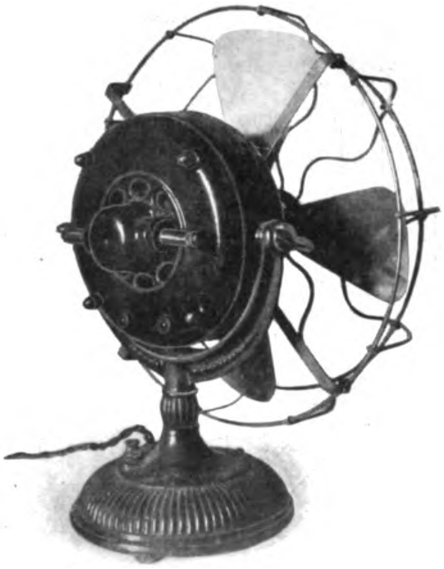


FIG. 12.—COMPLETE MOTOR.

It is only necessary in ordering these two parts to specify the diameter of the fan, size of the shaft, and the distance apart of the machine screws which hold the fan guard on. The motor is intended to drive a 12-in. fan at 1600 r.p.m. on a 110-volt circuit.

INTERIOR WIRING.

THE WIRING OF A LARGE HOTEL.

BY CHARLES E. KNOX.

The present article of this series will be devoted to the consideration of the characteristic features of the electric light wiring of a large hotel building. So far as the electric wiring is concerned, a hotel may be considered as being divided into three distinct portions; namely, the working or service portion, the public portion, and the apartment or bed-room portion. The first usually includes the basement and cellar floors, the second includes the ground or first floor, and the third the apartment or bed-room floors. (On account of space limitations characteristic floor plans of the latter two portions only will be shown in this number.)

The service or working portion of the hotel usually includes the kitchen, serving rooms, storage space, machinery, etc. The lighting of these portions is relatively simple. The lighting of the kitchen and serving rooms is, in the majority of cases, most effectively and economically accomplished by means of cluster fixtures, although drop cord outlets are used to advantage in some cases. If cluster fixtures are used they should be controlled by local push-button switches, as the fixtures usually have short stems and the key sockets at the lamps are therefore quite out of reach. Special receptacle outlets should be placed under the hood, over the kitchen ranges. The engine, boiler, pump and other machinery rooms are generally best lighted by means of

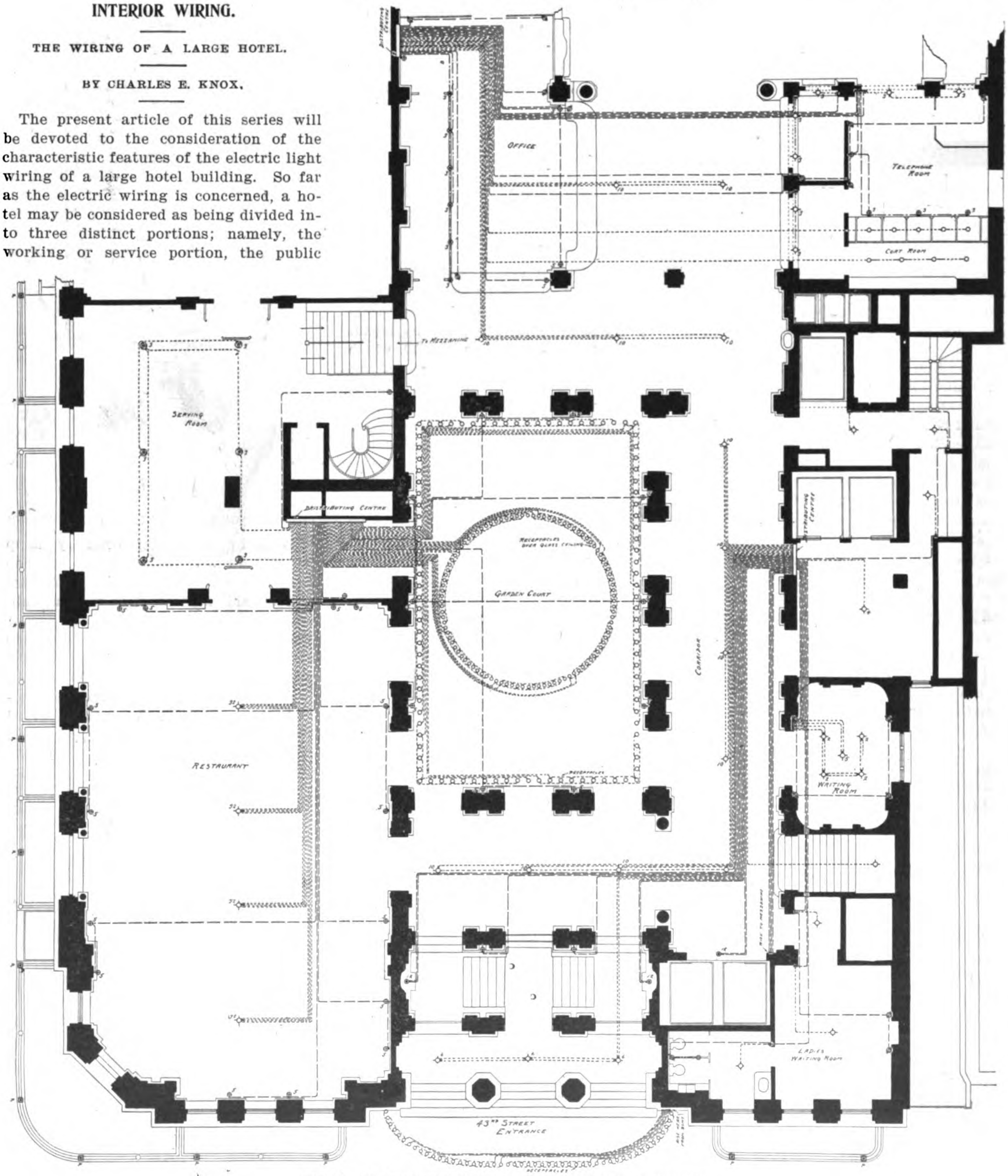


FIG. 1.—GROUND FLOOR PLAN AND DIAGRAM OF WIRING.

drop cord and wall socket outlets, placed with special reference to the machine, or portion thereof, to be lighted.

The lighting of the second (public) portion of the hotel, should for obvious reasons be more or less decorative in effect, and on a larger and more splendid scale than the rest of the house. It is therefore necessary not only to provide a large number of lights on these floors, but to obtain a suitable grouping and arrangement of the lights themselves. To this end a conference between the architect and the electrical engineer should be held for the purpose of fully discussing the question of lighting.

The restaurant is usually lighted by ceiling and bracket fixtures. In some cases individual lights on the tables are used, but this is rarely the case, owing to the difficulty of getting wires to the tables. Where it is possible to decide beforehand on exactly what points the tables will be located, the current supply can be carried to the table lights by means of floor outlets. It is usually impossible, however, to locate the tables beforehand, and it is rarely attempted. Of course, base plug outlets may be used for connecting with tables placed against or near the walls. The lighting of the café, palm garden and other rooms of similar character is usually less conventional than that of the restaurant, for the reason that the architectural treatment of these rooms is generally quite different from the restaurant.

The lights in the restaurant and café should be controlled at a point either inside or just outside the room in which the lights are located. These switches should preferably be placed in the cutout cabinet at which the branch circuits originate. The lights in the entrance corridor, etc., should generally be controlled at the hotel office.

Coming to the third (apartment) portion of the hotel, the first point to be decided upon is the number of lights to be allowed for an average-sized bed room. If it be necessary to keep the number of lights down to the lowest limits, ceiling outlets should be dispensed with and two single side bracket outlets provided, one located on each side of the bureau or dressing table. If the scheme of lighting permits a more elaborate scale, a ceiling outlet or base plug outlet for a reading light may be added, and in some cases both may be provided. Each of the rooms at the Waldorf-Astoria Hotel was provided with two wall lights (one on each side of the bureau), a ceiling outlet and a base plug near the bed for a reading light. The number of lights in the ceiling fixture varied, of course, with the size of the room. The ceiling lights were controlled by two switches placed near the door, one switch controlling a single light (called the "night light") and the other switch controlling the remaining ceiling lights. The side bracket and reading lights were controlled by the key sockets only. A light was also provided in each bed-room closet. This closet light was

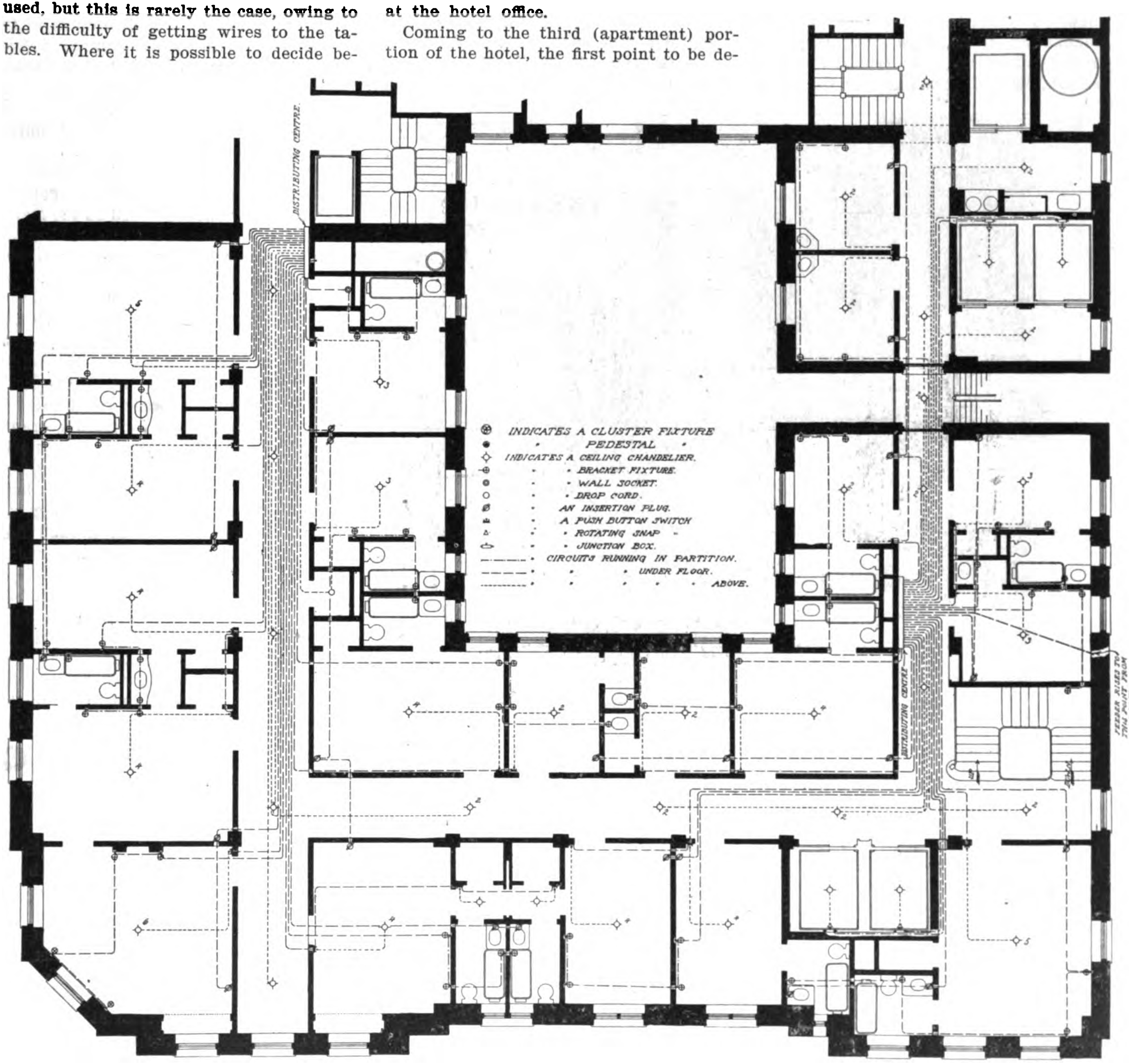


FIG. 2.—PLAN AND WIRING DIAGRAM OF EACH OF THE UPPER FLOORS.

controlled by a push-button (not a door automatic) switch placed just inside the closet door.

In locating the side lights and base plug outlets in the bed rooms it is essential to first lay out the furniture in the rooms so as to have the outlets come in the proper places. This can most easily be done by making paper templates of the bed and bureaus, on the same scale as the plans, and then arranging these on the plans in the best positions. The lights can then be located to suit the particular arrangement in each case. The arranging of the furniture on the plan should, of course, be done by the architect, or with his assistance and under his supervision.

For the purpose of illustration the writer has selected as a typical example of electric light wiring in a large hotel, the new Forty-third street extension of the Manhattan Hotel, New York City. As stated before, only two typical floors are shown. Fig. 1 shows the wiring of the ground floor, and Fig. 2 shows the characteristic features of the upper (bedroom) floors. The current supply is direct current at 110 volts pressure, and is derived from the generating plant in the cellar.

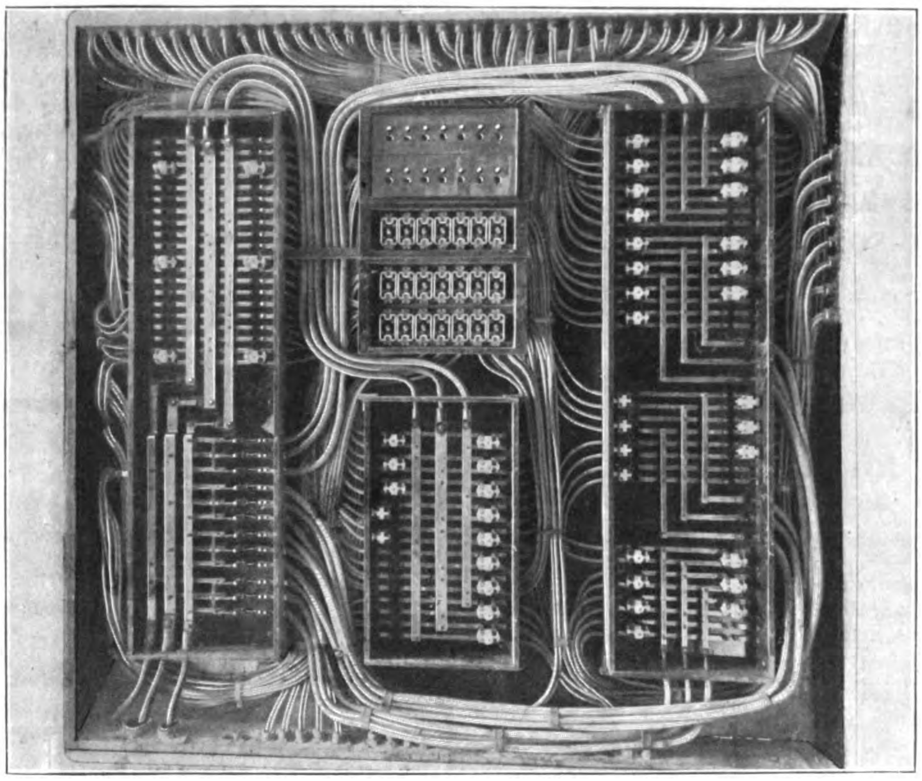


FIG. 3.—WALL CABINET IN THE SERVING ROOM ON THE GROUND FLOOR.

Ground Floor.—Fig. 1 shows the Forty-third street end of the ground floor and includes the restaurant, garden court, office, entrance, waiting rooms and corridors, etc. The lights on this floor are supplied from three centers of distribution located where shown on the plan. Fig. 3 is from a photograph of the distributing center located in the serving room of this floor. The photograph was taken by the writer before the doors and trim were placed in position on the cut-out cabinet, and shows the panel boards, switches, removable fuse-holders, connections, etc. It is possible to trace in this figure the various connections between the main panel boards at the left side and the lower portion of the center, and the subsidiary groups of cut-outs at the right side. The latter four groups of cutouts serve to protect the lights in the garden court; the circuits are controlled by knife switches located on the main left-hand panel. The lights on the ground floor are (except where local switches are shown) all controlled by switches located at the three distributing centers. The circuit lines, outlets, switches, etc., are shown diagrammatically in both Figs. 1 and 2. The explanation of the symbols is given in Fig. 2.

Restaurant.—Each of the four ceiling lights in the restaurant is supplied by four branch circuits originating at the center of distribution in the serving room. The side bracket fixtures are (with two exceptions) supplied in pairs, by branch circuits also originating at this center. Each of the branch circuits supplying lights in the restaurant is controlled by a push-button switch located in the cut-out cabinet.

Garden Court.—The garden court is lighted by two separate groups of individual lights. The first group forms a rectangle along the sides of the ceiling and consists of 102 receptacle lights placed in plaster rosettes specially designed for the purpose. Only the lamps themselves are visible from below, although the outlet boxes and connections are accessible by removing a small metal canopy covering the orifice of the outlet box. The lamps are wired in alternation, and are supplied by 14 branch circuits originating at the serving room centers of distribution. These lights are controlled in two groups by knife switches located at that cut-out cabinet (see Fig. 3). One group consists of 53 lights, the other of 49 lights. The second main group of lights in the garden court consists of 100 receptacle lights placed above the circular stained-glass ceiling or skylight. These lights serve the double purpose of supplying general light in the garden court and to illuminate the stained-glass ceiling or dome. The outlets themselves are accessible from above the glass ceiling. The lights are wired in alternation and are supplied by 14 branch circuits originating and controlled at the serving room distributing center. The lights are controlled by knife switches at that point, in two groups of 50 lights each.

Corridor.—The lights at each of the ceiling outlets in the corridors are supplied by two separate branch circuits; each branch circuit supplies lights at two or more outlets and is controlled by a push-button switch located at the center of distribution at which the circuit originates. This makes it possible to have all or part of the lights at these outlets turned on, as may be required.

Office.—The office is lighted partly by bracket outlets located on the columns and partly by outlets placed on the marble railing at the rear of the office. Plug outlets have also been provided for making connections to desk outlets.

Outside Lights.—The outside lighting is provided for by a group of receptacle outlets over the main entrance and pedestal fixture outlets located above the railing along the front and sides of the hotel. The 50 receptacle outlets are located in an iron canopy over the main entrance. They are supplied by branch circuits originating in the basement, but are controlled (through mains) by two knife switches located at the distributing center in the corridor at the ground floor (see also Fig. 4). The outside standard outlets (market P in Fig. 1) consist of 12 lights each and are supplied by 13 separate branch circuits originating at a distributing center in the basement. The entire group is controlled by a knife switch at that point. Each circuit runs along the basement ceiling to a junction box placed under the corresponding pedestal fixture on the sidewalk; thence the circuit rises in conduit through the stone coping and up through the iron pedestal itself to the fixture at the top of the pedestal.

The coat room and telephone booths are lighted by drop cord outlets, as shown. The lavatory in the ladies' waiting room is lighted by a single receptacle outlet placed on the partition between the closets. The conduit for this outlet runs to a junction box located in the wall at the level of the top of the partition; from this box the conduit runs along the top of the partition to the special receptacle on the partition.

Upper Floors.—There are two distributing centers at each of the upper (bedroom) floors, at which the branch circuits for these floors originate. Each of the bed rooms is lighted by a ceiling outlet, two side wall (bureau) outlets and a base plug outlet near the bed, for serving a reading light. The ceiling lights are controlled in one group by a push-button switch placed near the door. The bracket and plug outlets are not controlled by switches other than the key lamp sockets on the fixtures. The bath rooms are lighted by side bracket outlets placed beside the wash basins. In the larger rooms the extra wash rooms between the bath rooms and the closets are lighted by side bracket lights placed on each side of the basin, as shown. The bath rooms attached to the larger outside rooms are also provided with plug outlets serving for connection for curling-iron heaters, milk warmers, etc. The ceiling outlets in the corridor are wired in alternation so that every other outlet may be lighted, in case all the lights are not needed. The switches for the corridor lights are located at the distributing center at which the circuits originate.

Feeder System.—As will be seen from the diagram, Fig. 4, the cellar, basement and ground floors are supplied by separate feeders. This is done because of the great importance of having continuous and uninterrupted lighting service at these floors. The three distributing centers at the cellar are supplied by a single feeder which terminates at one of the centers and supplies the other two by means of mains extended from the feeder. Three of the eight distributing centers at the basement floor serve to supply the outside lights, as described above. The distributing center for the outside street lamps is supplied by a separate feeder from the main switchboard. The centers for the receptacle lights over the entrance are supplied by mains from the distributing center in the corridor at the ground floor. The other five distributing centers at the basement floor serve for the basement lights only; they are fed by two separate feeders, one of which serves two centers and the other three centers, as shown. Each of the three centers at the ground floor is supplied by a separate feeder.

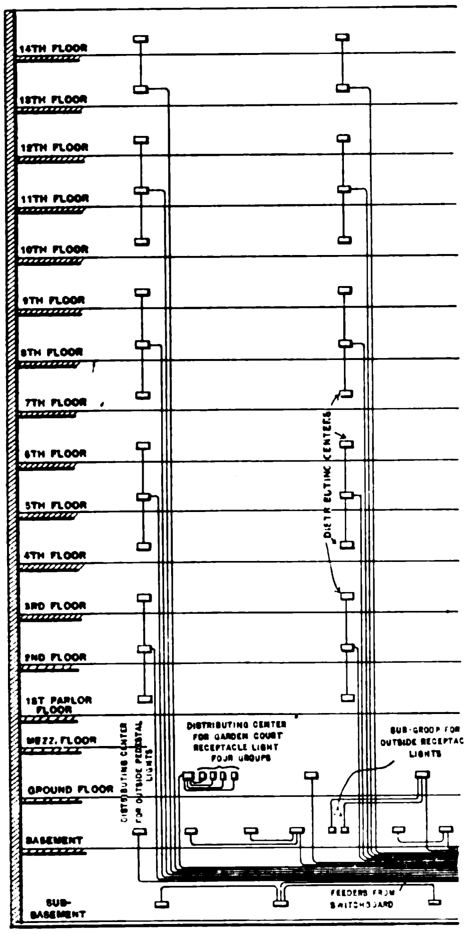


FIG. 4.—DIAGRAM OF RISERS.

The upper floors from the first to the fourteenth inclusive are divided into two symmetrical sections. Each section has its own distributing center, and its own set of supply feeders. The distributing center in each set is located at the same point at each floor. Each feeder from the first to the twelfth floor inclusive serves to supply three distributing centers. The feeder terminates at the middle center of a group of three, and is extended by mains to the corresponding centers at the floors immediately above and below. In the case of the thirteenth and fourteenth floors, the feeders terminate at the thirteenth floor and are extended by mains to the corresponding centers at the fourteenth floor.

◆

REPAIRING AND CONNECTING UP A GENERATOR COMMUTATOR.

BY A. B. WEEKS.

If the commutator has been off for some time, clean the shaft and commutator shell thoroughly, and see that the key and keyway are free from burrs. Push the commutator on as far as it will go, then get a large piece of cotton cloth and sew it around the rear ring of the shell, so that no short-circuits shall occur at this place. Tie strings to the cloth and poke them through the ventilating holes at the rear end of the armature. Then, by means of long rods run through holes in the commutator core (marked H in the sketch) and continued through the armature spider to a piece of heavy strap iron placed across the far end of the shaft, force the commutator to place by setting up nuts on the ends of the rods. White lead should have been put on the shaft at the commutator bearing.

When the commutator is within half an inch of the armature conductors, it is necessary to space the latter so that they will go into the slots in the commutator lugs; this is done by driving tapered hardwood wedges between the armature conductors near the outside end. Then put on a temporary band wire near this end to retain the wires in this position. When they are all entered and the commutator is up to place, take out these wedges and drive them along the side of each commutator lug or connector in order to wedge the armature conductors into place as securely as possible. This done, get ready for soldering, by packing pieces of plain cotton cloth firmly between the armature bars and pushing them back far enough to lap over the inside edge where the cotton cloth has been sewn. Leave the wedges in place until through soldering, which may be done as soon as the irons are ready. Have at least six gasoline soldering pots and some one to keep them going and also to keep the irons in good condition.

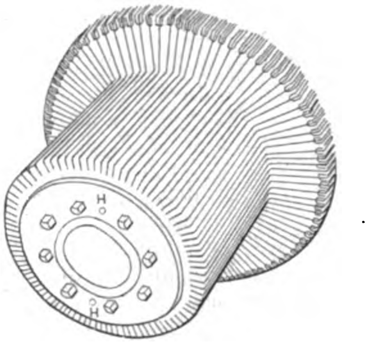


FIG. 1.—COMMUTATOR.

Having completed this part of the work remove all surplus solder, and if there is no convenient way of turning, file the soldered surface with a bastard file, finishing with a smooth file, remove the wedges and clean off the solder from all of the connectors. Take out the cloth packing, pull on the strings that are fastened to the cloth to remove it, and blow out very thoroughly.

◆

WATER OF CONDENSATION.

BY C. W. OBERT.

Water of condensation will be formed inevitably whenever steam passes from a boiler directly into cool pipes or from hot pipes into a cool cylinder, due to loss of heat in heating up the surfaces and walls of the pipes or cylinder. This loss of heat from the steam is absolutely unavoidable since heat will always transfer from hot to cooler bodies, and it is impossible to prevent such loss except by jacketing the pipe and cylinder surfaces and heating them to a temperature equal to that of the steam. The plan of jacketing and heating externally by the application of steam or hot air is ordinarily so expensive and complicated as to be impractical except in cases where extraordinary advantages are obtained, as in an engine cylinder. The plan of internally heating pipes and cylinder surfaces is, however, proving to be so efficient that a more general adoption of it may be reasonably expected in the future; it is accomplished, of course, by using superheated steam. Such extra-heated steam is able to lose a very considerable portion of its heat in raising the temperature of the pipe and cylinder walls without being cooled enough to cause condensation.

In ordinary practice, not prevention but only a reduction of the condensation is attempted. By covering the steam pipes, cylinders and steam passages with some approximate non-conductor of heat, the radiation of heat from their outside surfaces is greatly reduced; consequently the loss of heat and the resulting condensation of the steam are also reduced. With the best of pipe covering, however, there will inevitably be some radiation of heat and resulting condensation of steam. And in any case, whether the pipes, cylinders, etc., are covered or not, there will be very profuse condensation when steam is first admitted into them, because they are then cold or at least very much cooler than when in active use.

If the water of condensation is produced in very small quantities, it will be carried along or entrained by the steam, in which case it naturally cannot accumulate. In fact, small quantities of water will not remain in a pipe through which steam is passing at its usual velocity. But if condensation takes place faster than the entraining action of the steam can carry away the water, as happens in pipes or passages which are directly exposed to cold air, accumulations of water will form which, if not properly disposed of, will cause trouble.

The results of "taking water" by an engine cylinder are painfully familiar to most engineers, but a consideration of the action in detail may be of interest. Unless the amount of water carried into the cylinder is insufficient to fill the clearance space, it will be caught between the piston and the cylinder head in the immediately following exhaust stroke. Since water is very sluggish in its movement as compared with steam, it will not flow out of the exhaust ports readily with the exhaust steam and make room for the full travel of the piston; it passes out at the port so slowly as to form practically a solid barrier behind the piston, and, owing to its almost absolute incompressibility, acts like so much metal, preventing further free movement of the piston. Ordinarily the moving parts of the engine might be expected to simply stop under such restraint, but, at that point of the piston travel it is driven not only by the force of the expanding steam on the "live" side, but also by the inertia of the flywheel acting through the crank and the connecting rod, which, as the crank pin is then nearing its dead center, are forming a straightening elbow joint having the tremendous leverage of a toggle-joint.

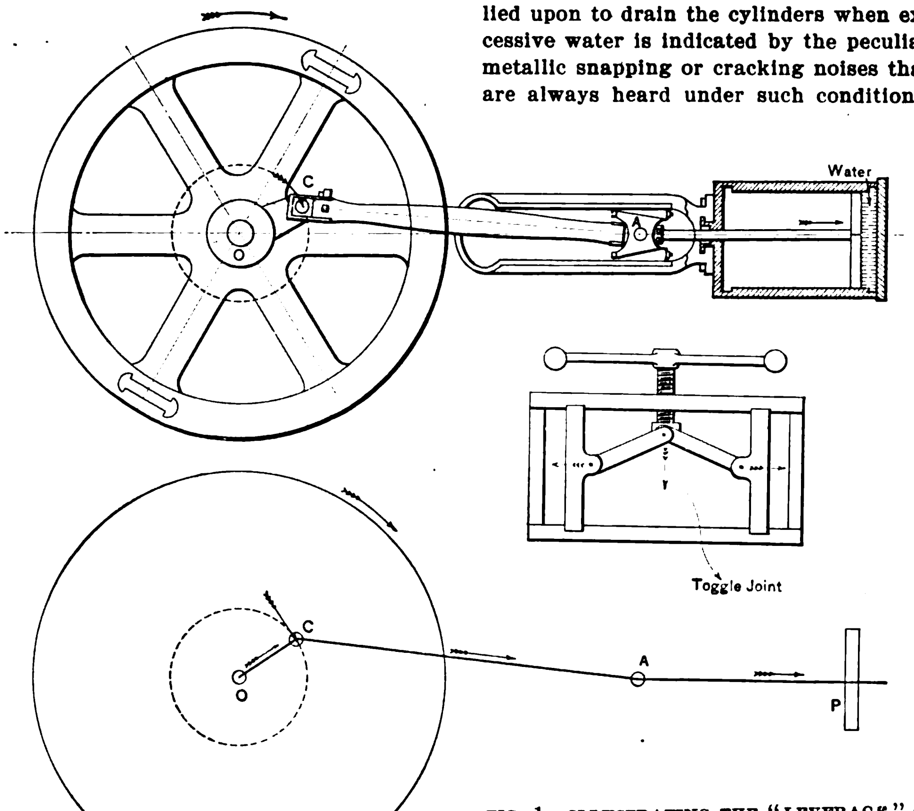


FIG. 1.—ILLUSTRATING THE "LEVERAGE" OF A FLY-WHEEL OVER A PISTON AND THE RESULTING FORCE EXERTED UPON THE PISTON.

Thus, in Fig. 1, the inertia or stored energy of the fly-wheel is forcing the crank pin, C, nearly straight downward, giving a wedging effect which tends to drive the points O and A apart. As O, which is the center of the shaft, is always very rigidly supported, the point A, and consequently the piston rod, is pushed to the right with great force. The lower part of the engraving is a diagram of the forces.

The liability of water to do harm in the cylinder is greatly reduced when the exhaust ports of the engine valves are placed on the bottom of the cylinder so that the tendency will be for such water to drain out before becoming imprisoned between the piston and the cylinder head. However, many engines are not so built, in which case the cylinder cocks must be relied upon to drain the cylinders when excessive water is indicated by the peculiar metallic snapping or cracking noises that are always heard under such conditions. For further protection in such emergencies, automatic relief valves are sometimes provided. These valves, known as snifting valves, are arranged to open outwardly from the clearance space in the event of extreme pressure inside, being held shut under ordinary conditions by a heavy spring. Fig. 2 shows the construction of a snifting valve. It consists of a plain conical valve disc, V, which is held upon its seat by the spring, S, and this spring may be compressed by the adjusting nut, N, to hold the valve shut against all ordinary working pressures in the cylinder, but to open outward for relief at any higher pressure. This device is not, however, to be thoroughly relied upon as a protection at high speeds, because in a high-speed engine the damage may be done before the snifting valve can deliver enough water to ease the pressure, as was demonstrated recently in an accident to a high-speed engine so equipped.

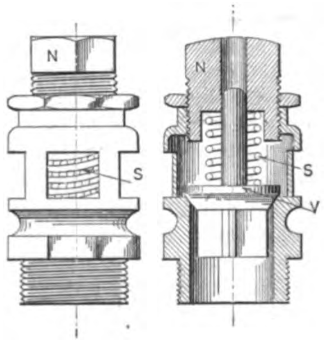


FIG. 2.—SNIFTING OR RELIEF VALVE.

Entrained water is much more easily taken care of by preventing it from reaching the cylinder than by attempting to get it out after it has once got in. By far the best disposal that can be made of condensation in the steam pipe is to grade the pipe so that it slopes gently downward from the boiler toward the engine and then place a receiver in the pipe, close to the engine, to catch all water draining toward it as well as that entrained by the steam.

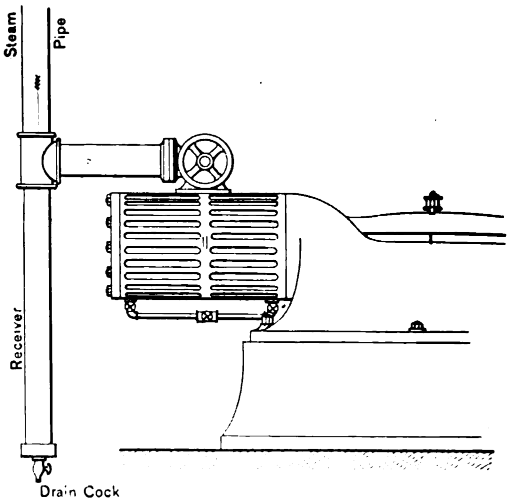


FIG. 3.—RECEIVER FOR ENTRAINED WATER.

There are several different forms of receivers for this purpose in successful use, all of which consist broadly of an extension or an enlargement of the steam pipe into which condensation water may drain by gravity and collect, to be drawn off at convenience. Perhaps the simplest form that may be used is that shown in Fig. 3, which is merely an extension of the vertical part of the steam pipe downward beyond the elbow leading to the throttle valve. The water carried along by the steam will be carried past the elbow into the extension by the combined effect of inertia and gravity. As water collects in the extension it can be drawn off at intervals, of course.

A much more effective form of receiver is the separator, of which some commercial forms are shown by Figs. 4, 5, 6 and 7. This apparatus accomplishes the same result that the receiver does, but in addition it gives the steam a whirling or centrifugal motion as it enters, so that the finely divided drops of water tend to fly to the outside while the lighter dry steam remains toward the center and passes out first through a central opening into the steam pipe beyond. The water thus thrown outward lodges on the walls of the separator and trickles to the bottom. In some forms of separator, the action depends upon capillary action on perforated or roughened metallic baffle plates placed in the path of the steam, the centrifugal action being partially discarded. In those types, of which the Austin is representative, the small particles of water are hurled against the baffle plates, on which they stick and collect, finally dropping into the reservoir below. Combinations of these two fundamental principles are sometimes made use of in separators, giving very effective and satisfactory results. A separator is very efficient if large enough, but not when it is too small, and many separators in use are inefficient for this reason. Well-designed separators have, under test with reasonably dry steam, shown the remarkable result of delivering steam containing less than one per cent (by weight) of water.

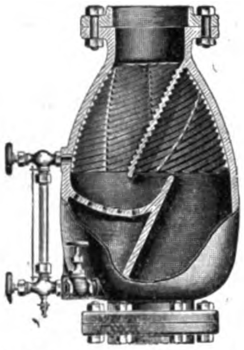


FIG. 4.—BAFFLE-PLATE SEPARATOR.

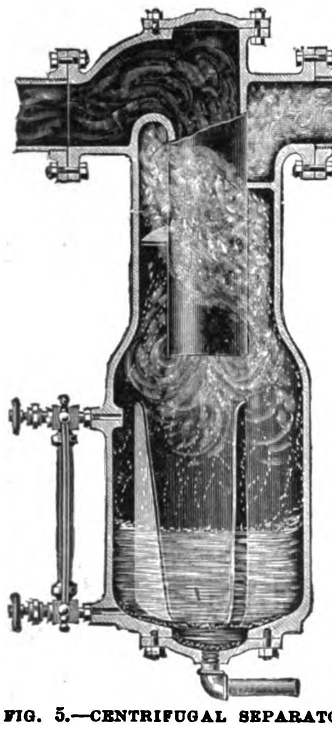


FIG. 5.—CENTRIFUGAL SEPARATOR.

◆

WEAK FIELDS AND GROUNDED ARMATURES.

BY FRANK BERRY, JR.

The armature of a railway motor is, under ordinary circumstances, the first part to break down under a heavy strain which may be put upon it mechanically or electrically. If the field of a railway motor be unbalanced to any extent it throws a severe strain on the armature, which ultimately breaks it down. Weak fields may result from a variety of causes: a fast feeding controller, insufficient insulation, short-circuited armature coils, or a few "bridged" commutator segments, which may have got in this condition by using acid and solder too freely. A motor whose fields are unevenly balanced will assert itself by flashing at the brushes, "bucking," and running much warmer than its mate. This is more readily noticed when the motors are thrown in parallel.

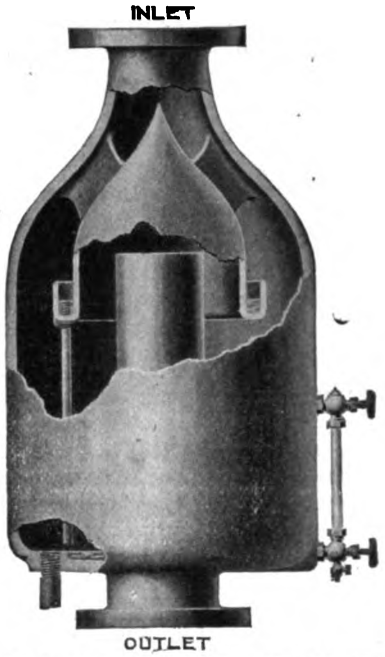


FIG. 6.—BAFFLE-PLATE AND CENTRIFUGAL SEPARATOR

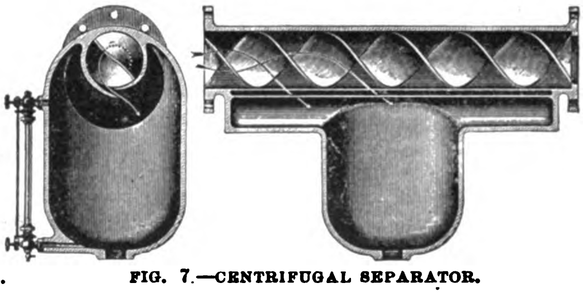


FIG. 7.—CENTRIFUGAL SEPARATOR.

A fast feeding controller can always be remedied by connecting up the resistance so that the controller will cut it out more gradually. This trouble may often be noticed on a road where there are used two controllers of different type, having the same number of connections at the hose, but having the contacts on the drum connected differently, as a well-known controller has. One controller is sometimes set up where the other should be used, without any attention being paid to the resistance until the car is turned in for "bucking," blowing fuses or, more frequently, with a grounded armature. It has come under the writer's observation many times that controllers were connected up so that on the first or second notch the motors were in series directly between trolley and ground.

Short-circuited armature coils may result from some damage received while the coils were being formed, or in course of assembling on the armature, but short-circuits are often due to extremely poor insulation. Judging from appearances, it would seem that the less shellac and tape the armature winders use, the better it is for that which they may be insulating, whereas it is, of course, well known that the more insulation there is on armatures and fields the less liable they are to break down. If this perfectly obvious fact were more generally borne in mind there would not be so many weak fields and grounded armatures; hence the repair bills would be greatly lowered.

◆

COMMON BATTERY TELEPHONE SWITCHBOARD SYSTEMS.

BY W. S. HENRY.

In a common battery system the apparatus at the subscribers' telephone may be arranged in a variety of ways. Before taking up the complete connections of an exchange system a few of the ways for connecting the subscribers' apparatus will be shown. Unless specified to the contrary, the ones shown may be used with either tne Hayes, Stone or most any other method, excepting the Dean, in which direct current for the transmitter is supplied through the two line wires and an alternating current is sent through the same two line wires when the subscriber's bell is to be rung. In some systems the ground is used as one path for the ringing current, either one line wire or both line wires in parallel being used for the other path. In such cases the bell at the subscriber's station is connected between either one or both of the line wires and the ground.

In Fig. 6 is shown one method of connecting the subscriber's station and the circuit at the switchboard by means of which the subscriber can call up the operator. At the subscriber's station the polarized bell, E, and a condenser, C, are connected in series permanently across the two line wires. The transmitter and receiver are in series but are only connected across the two line wires when the receiver is removed from the hook. At the switchboard an impedance coil, I, a signaling battery, B, an annunciator, D, and a spring jack, J, are all in series with the line wires. When the receiver is on the hook no current can flow in the circuit from the battery, B, because the condenser, C, is included in the circuit. However, when the receiver is removed from the hook the transmitter, T, and receiver, R, complete the circuit between the two line wires and they allow enough current to flow from B to drop the shutter of the annunciator, D.

When the operator inserts a plug in the jack, J, the circuit containing the annunciator is opened at the jack by the lifting of the upper spring from the contact under it. The operator, by inserting a plug in the jack, can evidently ring the bell, E (provided, of course, that the receiver is on the hook, T), by pressing a ringing key, thereby connecting the terminals of an alternating - current generator across the cord circuit and hence across the two line wires. This alternating current can act through the condenser and cause the bell, E, to ring.

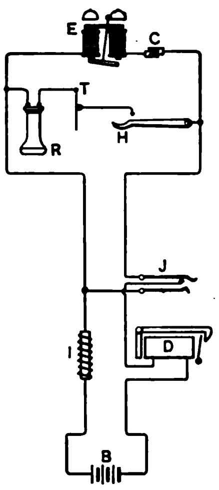


FIG. 6.

The battery, B, is common to all the telephone lines, and in order to avoid cross talk and other disturbing noises that may result from connecting all the line wires together at the battery terminal, an impedance coil, I, is placed in the circuit of each line between one pole of the battery and the spring jack. All the apparatus shown, excepting the battery, B, is duplicated for each telephone circuit. The coil, I, is adjusted for each line so as to allow the same current to flow in each line when the receiver is removed from the hook.

There is an objection to connecting the annunciator, D, directly in the line circuit, although this is the simplest way of arranging the signaling circuit at the switchboard. This objection is the difficulty of maintaining the resistance of the various line circuits at a practically constant value; and a lowering of the resistance, such as would be caused by a short-circuit between the two line wires, for instance, would allow an excessive current to flow from the battery, B, through the annunciator, D, which would be likely in many cases to burn out the magnet. As already stated, the resistance of the impedance coil may be adjusted to give each line the same resistance but this does not prevent a change in the resistance of the circuit due to crosses or other causes. Where the lines are all run in cables indoors this is not so great an objection as it would be on overhead bare wire lines. The condenser, C, at the subscriber's station may be omitted, as shown in Fig. 7. When this method is used the bells at the subscribers' stations should be wound to a very high resistance, 1000 or 2000 ohms, in order that the current normally flowing from the battery, B, when the receiver is on the hook may be very small and therefore not very wasteful. Other arrangements at the switchboard will be shown later.

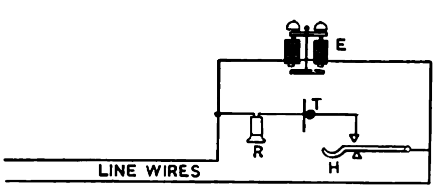


FIG. 7.

Fig. 8. shows the arrangement of the apparatus at the subscriber's station used by the Stromberg-Carlson Company. The battery current coming over the line wires passes through the transmitter, T, and the primary winding, p, of an induction coil. The operation of the transmitter varies this current and so operates the distance telephone; for if a variable current from a distant telephone arrives and passes through the primary of the induction coil, it will induce an alternating current in the secondary winding of the coil, thus causing the receiver, R, to reproduce the original sounds. This method has the advantage of not having the resistance of the receiver or of the secondary winding of the induction coil directly in the line circuit. Moreover, since the receiver is not in the line circuit no care need be taken to connect it in a certain direction with reference to the direction of the direct current flowing in the line. In all systems where any appreciable direct current, as in Figs. 6, 7 and 9, can flow through the receiver, the latter must be so connected that the steady battery current that flows through it tends to increase the magnetism due to the permanent magnet; otherwise the receiver will be wholly or at least partially demagnetized, rendering it useless or very inefficient.

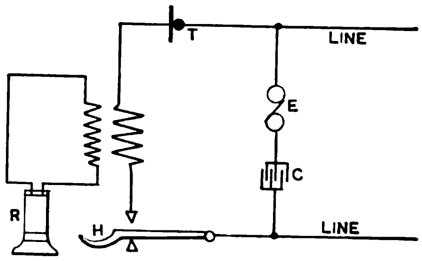


FIG. 8.

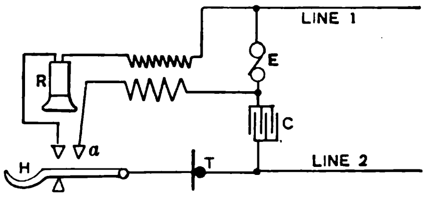


FIG. 9.

In the arrangement illustrated by Fig. 9, which is used by some companies, care must be taken to connect the receiver, R, in the circuit so that whatever direct current from the battery at the central office may flow through it will not tend to demagnetize it. When the receiver is off the hook, a portion of the battery current can flow from line 1 through the bell, E, the primary winding of the induction coil and the transmitter, T; and a portion of the current can flow from line 1 through the induction coil secondary, the receiver, the hook and the transmitter, to line 2. Incoming voice currents, as we may call the alternating or very rapidly fluctuating currents, cannot pass through the bell magnet, E, near so readily as they can pass through the induction coil and the receiver, because the impedance of the bell, E, and the primary winding of the induction coil, which are in parallel with the receiver circuit, are of very high impedance. The voice currents after passing through the receiver, R, may reach line 2 either through the hook, induction coil and condenser, or through the hook and the transmitter; the high frequency voice currents can readily pass through the condenser, C. In this arrangement the bell, E, should not have too high a resistance, otherwise the transmitter cannot get sufficient current with the voltage usually employed.

Lessons in Practical Electricity

ACTION OF AN INDUCTION MOTOR ARMATURE OR ROTOR

As explained fully last month, two coils disposed at right angles on a single core, such as an armature core, and supplied with alternating currents differing in phase by a quarter cycle, will produce a bipolar magnetic field that will rotate in a circle concentric with the core. Now, if the coils be mounted within a ring-shaped core, as in Fig. 1, the result will be precisely the same except that the magnetic poles will be manifested on the interior of the ring. Such an arrangement would be designated a bipolar field, because the two fields produced individually by the two windings combine in a single rotating field within the ring, whose axis is diametral with regard to the hole in the ring. The construction indicated, however, is not practical; in order to allow the insertion and removal of an armature, each of the field coils must be divided into two, and the four resulting coils disposed somewhat as

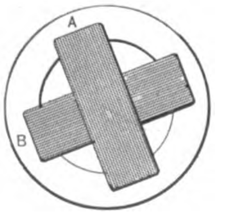


FIG. 1.

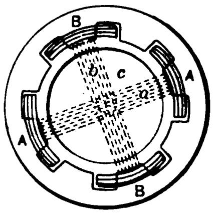


FIG. 2.

indicated by Fig. 2, so that an armature core, C, may be inserted in the central hole.

In this event the two coils marked A assist each other in producing a flux, *a*, across the central core, and the coils marked B produce a similar flux, *b*, at right angles to this, the two combining in a single rotating field, as before. Thus, with maximum current in A and A, the current of B and B will be zero and a flux will be produced as indicated in Fig. 3; when the current in A and A falls to 0.707 of its maximum, that in B and B will have risen to exactly the same degree, and the resultant flux will occupy the position shown in Fig. 4. At the next eighth of a cycle the current in A and A is zero and that in B and B maximum, locating the flux as shown in Fig. 5; and so on, through the complete cycle, as indicated by Figs. 6 to 11. In these diagrams for simplicity the flux is represented by only two dotted lines which indicate its general direction across the core and its division in the ring. With the elementary construction shown, there would be a leakage flux around the sides of the field coils, as indicated in Fig. 11; for the present we must neglect this.

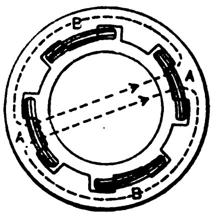


FIG. 3.

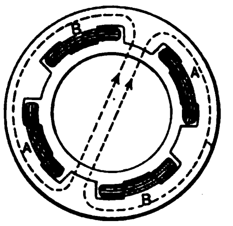


FIG. 4.

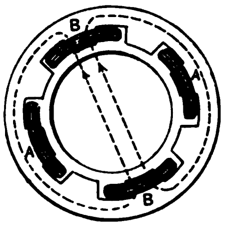


FIG. 5.

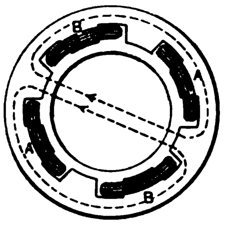


FIG. 6.

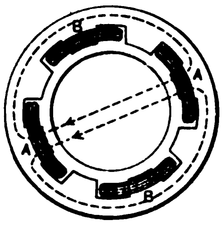


FIG. 7.

Now suppose a single turn of wire be wound on the drum core, as shown by Fig. 12, and the ends connected to form a closed circuit. If this core be inserted in the ring and held still while two-phase currents pass through the coils, the rotating field will be cut by the two wires on the drum every time it makes half a revolution, and will induce in each side of the loop an e.m.f. equal to

$$e = \frac{2.22\ n\ \Phi}{100,000,000},$$

where *n* is the number of revolutions per second made by the flux and Φ is the number of magnetic lines passing through the drum. Consequently the total e.m.f. induced in the loop on the drum will be

$$E_s = \frac{4.44\ \Phi\ n}{100,000,000} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The e.m.f. thus induced causes a current to flow in the armature loop, the magnitude of which, ignoring self-induction, will be determined by Ohm's law. The e.m.f. and current in the loop will, of course, be alternating, because the direction of the flux is reversed at every half revolution. Now, if the current attained its maximum value at the instant when the sides of the loop had been swept by one-half of the flux, the flux would exert a dragging effort on the wires tending to rotate the drum with a force equal to

$$\frac{2\ C\ l\ B}{11,303,000}\ \text{lbs.};$$

the current being represented by C, the length of the drum in inches by *l*, and the density in magnetic lines per square inch in the air-gap by B. The numerator includes the figure 2 because there are two active conductors at the periphery of the drum. Armature reaction and self-induction in the armature winding, however, have the effect of reducing the torque to a value much smaller than this formula would make it. A general formula might therefore be written thus:

$$T = \frac{W\ C\ l\ B\ k}{10,000,000} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

in which T is the torque in pounds; W is the number of wires around the periphery; C is the current per wire; *l* is the length of the core; B is the magnetic density in the air-gap, and *k* is a fractional constant covering the effect of armature inductance and reaction and the change in the denominator.

It is evident, however, that if the drum is left free to turn, the pull exerted by the rotating field upon the sides of the loop will drag the drum around. It will be also evident upon reflection that as soon as the drum begins to revolve, the wires on it will not cut so many lines of force per revolution as before, but will cut only a number proportional to the difference between its own speed and that of the rotating magnetism. Consequently, the e.m.f. induced in the armature loop will become less as its speed increases, and the armature current and torque will also become less; this will be clearer if the reader will consider that if the drum were driven by a belt at a speed equal to that of the magnetic field the sides of the loop would not be cutting any flux and there would be no e.m.f. induced in it. The operation of an induction motor, therefore, requires that the speed of its armature must be less than that of the rotating field by an amount sufficient to allow the armature conductors to cut the flux at a rate that will induce an e.m.f. in the conductors which will force enough current through them to give the requisite pull or torque to carry the load. Consequently, if load is put upon the afmature, its speed will be reduced until the current flowing will be sufficient to give the required torque.

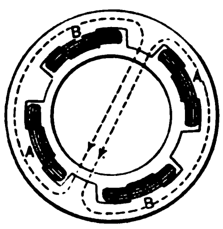


FIG. 8.

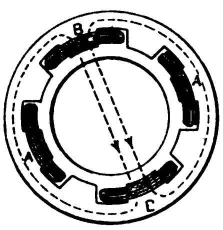


FIG. 9.

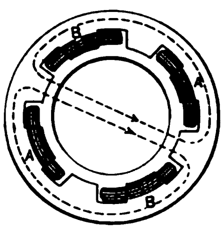


FIG. 10.

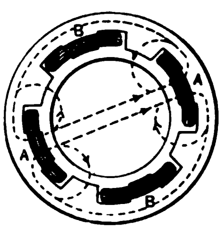


FIG. 11.

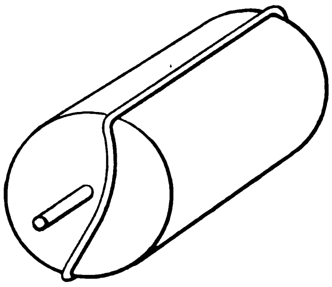


FIG. 12.

For example, still assuming the ideal condition of no lag by the armature current, and no armature reaction, if the speed at which the magnetic field rotates be 60 revolutions per second and the armature speed, running free, be 59.85 revolutions per second, the armature wires would cut 0.15 or 15 per cent of the total flux per second. Now, if the armature should have a load put upon it equal, say, to 20 times its friction load, the speed would be reduced until the wires would be cutting 20 times the number of lines of force previously cut; that is, the total flux would have to be cut 0.15 × 20 = 3 times per second. Consequently, the difference between the speed of the armature and that of the magnetic field would have to be 3 revolutions per second, which would bring the armature down to 57 revolutions. The difference between the armature speed and that of the rotating magnetic field is called the "slip," and it is usually written as a decimal, but referred to as a percentage. Thus, in the case just mentioned, with the armature making 57 revolutions per second while the speed of the magnetic field is 60 r.p.s., the difference of 3 r.p.s. is the slip, and its numerical value is 3/60 = 0.05; it would be reterred to as a slip of 5 per cent.

As stated in the beginning of this lesson, the resultant rotating field due to the combination of two (or more) alternating-current fields of different phases will have the same number of poles as each of the component fields. For example, in the elementary machine under consideration the flux set up by each pair of coils gives a bipolar field, and the two fluxes combined give a resultant rotating field which is also bipolar. Consequently, when one speaks of the number of poles on an induction motor it is always the number of poles per phase that is meant, which is equivalent to saying the number of poles of the resultant field formed by combining the two (or more) phases. The rotating magnetic field makes one revolution during each cycle of the magnetizing currents if the field is bipolar; the speed for more than two poles therefore would be

$$\frac{2\,n}{p} = \text{r.p.s.} \quad \text{(3)}$$

in which n is the frequency of the supply currents in cycles per second, and p is the number of poles.

As previously stated, the e.m.f. induced in the armature conductors will be alternating, and the frequency of this e.m.f. will vary inversely as the speed of the armature. The reason for this apparently contrary variation will be evident upon a little reflection. If the drum should be held stationary, the e.m.f. induced in the conductors by the rotating flux will have the same frequency as the supply current, but if the drum be driven by a belt at the same speed as the flux there will be no e.m.f. induced, and the frequency will therefore be zero. The frequency of the e.m.f. in the armature conductors is given by the formula

$$n_s = n \times s \quad \text{(4)}$$

in which n_s is the frequency of the e.m.f. in the armature conductors, n is the frequency of the supply current, and s is the slip expressed in terms of the frequency. For example, an armature running at 57 r.p.s. in a bipolar field produced by 60-cycle currents, would have a slip, as previously explained, of 0.05. The frequency of the current in the armature conductors, therefore, would be 0.05 × 60 = 3 cycles per second.

Formula (2) shows that multiplying the number of conductors on the armature core will increase the pull or torque. Thus, a core wound with four loops as in Fig. 13, would have four times as many conductors on its surface as the one shown by Fig. 12, and the current would be the same in each conductor because every loop has the same e.m.f. induced in it and is of the same resistance. The torque, therefore, would be practically four times as great. It would make no difference whether the loops were kept separate or connected in series, or in parallel as in Fig. 14; the latter construction is the simplest.

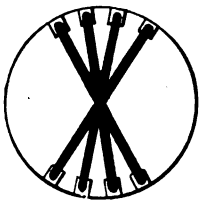


FIG. 13.

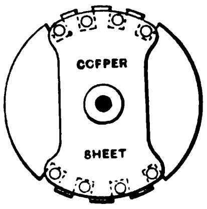


FIG. 14.

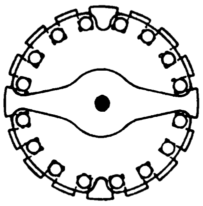


FIG. 15.

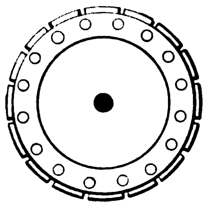


FIG. 16.

As previously shown, the speed of the armature is nearly equal to that of the rotating field, lacking only the small amount represented by the slip, and the field speed, or synchronous speed as it is termed, is $\frac{2\,n}{p}$ revolutions per second or $\frac{120\,n}{p}$ revolutions per minute. The frequency (n) ordinarily ranges from 30 to 60 cycles, so that a bipolar motor with a slip of 5 per cent would have an armature speed of 1710 r.p.m. at 30 cycles, or 3420 r.p.m. at 60 cycles—the more common frequency. This is, of course, too great for motors of any size, so that bipolar construction is seldom if ever used. The smallest machines are usually given four poles, and the number increases with the size of the machine and the frequency for which it is intended. The armature for a four-pole motor, evolved from the bipolar form of Fig. 14, would be constructed as indicated in Fig. 15. However, as there is no tendency for the currents in the two windings to interfere with each other, there is no reason why the two groups should be insulated from each other, so that the construction used in practice is made as shown in Fig. 16—the "squirrel cage" type.

Letters on Practical Subjects

Paralleling of a Direct Connected, and a Belted Generator.

To the Editor, American Electrician;

Sir:—I have to parallel a 200-kw. direct-connected dynamo and a 150-kw. belted machine, both 550-volt railway generators, running at 200 and 500 r.p.m. from separate engines of the same type. If any of your readers has met in his practice a similar problem I would be very much pleased to hear what his experience has been. Should there be any trouble in keeping them running together peaceably? John M. Schmidt.

Elkhorn, W. Va.

Mr. Chipman's Three-Wire Trouble.

To the Editor, American Electrician;

Sir:—Noticing Mr. Chipman's letter in your last number relative to trouble he was experiencing in operating two 110-volt shunt-wound machines on a three-wire system with a 220-volt compound-wound machine in multiple, I would say that this is occasioned from changes of load being unequally divided on his dynamos. When the load increases the compounded machine naturally takes up more than its share, from the fact that increased current in the armature goes through the series field thereby raising voltage and causing the greater part of load to be carried by this machine. On the shunt machines as load increases the voltage drops, thus causing the compounded machine to "back up" on them, so to speak; this will occasion the flashing at the commutator that Mr. Chipman mentions. If the load can be carried on the compound-wound machine alone, a simple remedy to be used in making changes would be a short-circuiting plug for the series field, which would cause this machine to operate as a simple shunt dynamo while it is in parallel with the other machines. The working voltage on the shunt machines would probably have to be lowered more than ordinarily in making this change, as the compounded machine with its series field winding short-circuited would not be likely to have sufficient range of voltage with the shunt field alone to bring it up to a point where it would take the portion of the load necessary before cutting out the shunt machines. By lowering the voltage sufficiently on the shunt machines this difficulty would be obviated.

If the conditions are such that it is necessary to operate the shunt and compounded machines continuously in parallel, better results could be obtained by disconnecting the series field from the armature circuit and putting it in series with the shunt winding, thus making a plain shunt machine of it; the range of voltage then would be wholly regulated by the field rheostat.

Palestine, Texas. Chas. W. Davis.

That Mysterious Current.

To the Editor, American Electrician;

Sir:—In the March number I notice among your notes on page 119 one entitled "A Mysterious Current." The phenomenon described occurs in a large alternating generator and consists of a difference of potential between the end of the shaft and the journal in which it runs, the machine being entirely free from grounds in both field and armature circuits. This difference of potential is accompanied by large current flow whenever substantial contact is made between journal and shaft, and it is presumed in the note that the oil film between journal and shaft constitutes the insulator to a certain extent. It is also stated that this potential increases with the load.

While the data concerning this curious phenomenon is not very full and the actual magnitude of potential difference and that of the current resulting therefrom have not been mentioned, it would seem that the probable explanation of the trouble is the following: The machine subbase with its shaft constitutes a one turn electric circuit. The revolving armature and such other iron as may be included constitutes the core, and the disposition of the winding on the machine and the wires leading out therefrom act to form an exciting primary; naturally, the current in the one turn closed secondary will increase in pressure and volume with the load as described. I would suggest an investigation of this point and a rearrangement of the dynamo leads.

New York. George T. Hanchett.

To the Editor, American Electrician;

Sir:—On page 119 of your March number, the note on "A Mysterious Current," observed in connection with the 1500-kw. alternators at the Snoqualmie Falls plant, describes a current that seems to be similar to that which I have observed in inductor alternators. It is a great deal more pronounced in the single armature type with the field coil on one side of the machine than in the double armature type with the field coil in the center.

While chief engineer for a manufacturing company, one of my duties was to design and test their inductor alternators. Often in testing a machine, sparking would occur between the shaft and journal, and sometimes a continuous ring of fire would appear around the circumference of the rotor, between the rotor poles and the stator laminations. It was found that small particles of iron, which had been attracted by the rotor poles, bridged across from these rotor poles to the stator laminations, thus making and breaking an electric circuit as the rotor revolved. It is plain to see the cause of this current, as the inductor machine is in reality a unipolar machine.

In the single armature type, where the rear end of the rotor is a cylinder, this end revolves inside the cylindrical surface of the frame with a small air gap between them. The field coil being stationary, the lines of force pass down through the frame, through the air gap and into the rotor, and are cut by the rotor surface as it revolves, thus generating a unidirectional current. There would be a current generated in the other half where the lines of force leave the rotor and pass into the armature laminations if it were not for the fact that the cylindrical surface is broken up by the poles, which are laminated.

The current flows from the rotor, along the shaft, through the journals, pedestals, and base to the other end of the shaft, if the electric circuit is not broken. However, in small machines, the potential of this current being very low, the resistance of the oil film between the shaft and the journal is sufficient to prevent this flow of current; and in the inductor alternators used for lighting and power there will be no trouble. In the machines of the larger capacities, say above 300 or 400 kilowatts, the oil film is not sufficient resistance to stop the flow of current, because the voltage generated in the rotor surface increases with the size of the machine, and would probably be too high.

If the electric circuit is complete, the current flowing would be proportional to the load on the alternating current coils. because as the load increases, the magnetic flux must necessarily be increased by a certain per cent, thus causing the unidirectional current to increase.

In the case of the Snoqualmie Falls generators I would suggest the introduction of some insulating material at some accessible point in the path of this superfluous current.

H. Stanley Carr,
Assistant Professor of
Electrical Engineering,
University of Kansas.

[The current referred to in reality was not mysterious, but was due to an error in the way in which the conductors from the armature winding were led to the collector rings, as suggested by Mr. Hanchett. It so happened that these were led in such a way as to give them the effect of the primary of a transformer, the secondary consisting of the shaft and bedplate connected through the bearings. When these conductors were carrying a heavy current a secondary current of low voltage was set up through the shaft, bearings and bed-plate, except when the bearings were sufficiently flooded with oil to form an insulation between the shaft and boxes. When the attention of the Westinghouse Company was called to this phenomenon, an examination was made showing the cause of the induced current, which was removed without any difficulty by a simple change in the position of the leads so as to prevent the inductive action which had previously taken place. The cause having been removed there is now, of course, no current in the shaft.—Editor.]

Another Plain But Efficient Trolley.

To the Editor, American Electrician;

Sir:—At the Highland Boy Gold Mining Company's smelter, Murray, Utah, automatic dumping hopper cars electrically-driven are used to carry the charges to and from the furnaces. The rails are not used as one side of the supply circuit, so that a double trolley is necessary. The overhead trolley is constructed as shown by Fig. 1. Two 2-in. angle irons are fastened by means of lag screws to a wooden stringer 2⅝ ins. thick, and the latter is capped with a V shaped roof. The trolley arm carries two brass contact shoes mounted on plungers and forced upward by coiled springs in the plunger sockets beneath. Fig. 2 gives a side view of the trolley pole. This arrangement has the advantage of not requiring the pole to be turned when the direction of the car is reversed; it works equally well in either direction. The contact shoes straddle the lower edge of the wooden stringer which carries the angle irons, and the trolley shoes are thus prevented from leaving the contacts. The e.m.f. of the circuit is 500 volts. C. D. Woodward.

Murray, Utah.

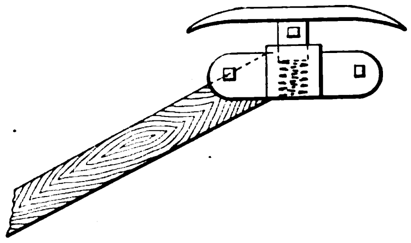


FIG. 1.—THE TROLLEY.

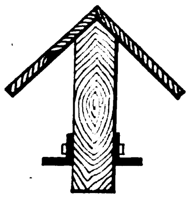


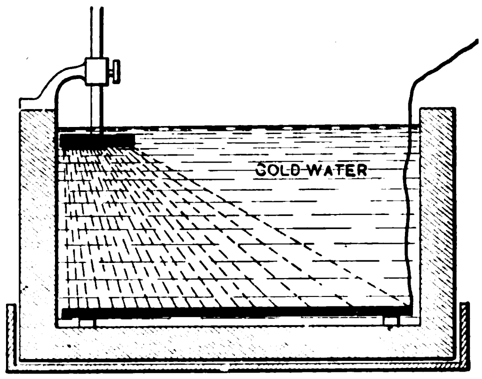
FIG. 2.—OVERHEAD STRUCTURE.

Points in Water Rheostat Construction.

To the Editor, American Electrician;

Sir:—I was interested in reading in your Electrical Catechism recently a description of water rheostats, and it has occurred to me that a few details in the construction of water rheostats which I have found of use in practice might be of interest to your readers in connection with the information already given by the Catechism. The rheostats with which I had experience are used in connection with electric hoists, and one of the difficulties encountered was the insulation of the wet rheostat box from the iron frame of the hoist. This was accomplished by putting the wooden box in a tin drip-pan, as shown by the accompanying sketch, and insulating the drip-pan from the hoist. The rheostat box was rectangular in shape, and the lower iron plate was made to cover almost all of the bottom of the box, as the drawing shows. The upper and movable electrode, however, was made to cover a much smaller proportion of the horizontal area of the water. It was a heavy iron ring mounted adjustably at one end of the box, as the sketch shows. With this arrangement only a part of the water served as an active conductor, and the remainder was not heated except by contact with the active part of the water. The result was a circulation of water within the box, which tended to keep the temperature down. The rheostat was used successfully for heavy loads and rough work. Francis H. Doane.

Scranton, Pa.



WATER RHEOSTAT.

Electrical Catechism

582. How is the heating effect of the current used for lighting?

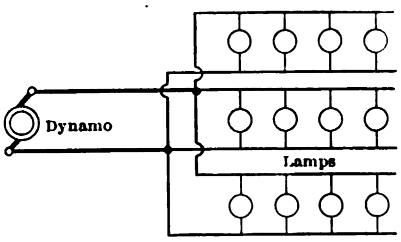
The heating effect is used in the incandescent lamp and in the arc lamp. In the former the current heats a filament of carbon to a high temperature; in the latter it heats the ends of carbon pencils or rods, the end of the positive carbon being heated to the melting temperature.

583. What are the parts of an incandescent lamp?

The lamp consists of a filament of carbon enclosed in a glass globe from which the air has been exhausted. Current enters and leaves through platinum and copper wires which connect the filament inside the globe with the brass cap outside. There are many different makes of incandescent lamps upon the market, differing in excellence according to the skill and facilities of the maker.

584. How are incandescent lamps usually operated?

They are generally connected in multiple between wires having a nearly constant difference of potential. For special purposes, such as lighting electric street cars or for lighting streets, a number of lamps are connected in series across lines having 500 or 1,000 volts or even higher.



LAMPS IN MULTIPLE.

585. What are the common voltages at which incandescent lamps are operated?

It was common to use from 50 to 55 volts with lamps lighted by alternating currents, but it is more common to use from 100 to 120 volts or from 220 to 250 volts. Lamps to be operated by current from batteries are made for 3 volts and upward. It is customary to have all the lamps on an installation for the same voltage, and new lamps should be ordered for the voltage regularly maintained. If the lamps are of too high voltage they will not light up with sufficient brilliancy, the filaments being only dull red or yellow. If the lamps are of too low voltage they will take too much current and will light up brilliantly, but will quickly burn out. As the lamps grow old they become dim, and sometimes it is practicable to move the old and dim lamps to positions nearer the dynamo where the voltage is somewhat higher.

586. What is the relation between voltage and candle-power?

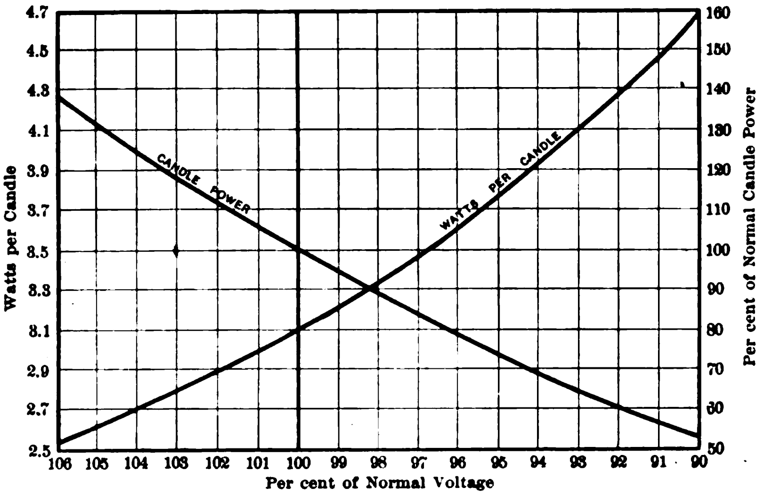
The candle-power of the light increases much faster than the voltage. For example, a lamp intended to give 16 candle-power at 105 volts will give only 14½ candle-power at 103 volts and will give 19 candle-power at 107 volts.

587. What is meant by the efficiency of an incandescent lamp?

The efficiency of an incandescent lamp usually refers to the number of watts absorbed per candle-power. For example, a four-watt 16-c.p. lamp would require four times sixteen, or sixty-four watts. The average practice in America is to use 3.5-watt lamps, the common efficiencies being 3.1, 3.5 and 4 watts per candle.

588. What determines the best efficiency to use?

The cost of power and lamps and the closeness of regulation of the voltage are the principal elements. The more costly the power and the cheaper the lamps, the higher should be the efficiency of the lamps. The life of the lamps is shorter when operated at high efficiency, and the life of the lamps is rapidly shortened if the voltage rises above the normal.



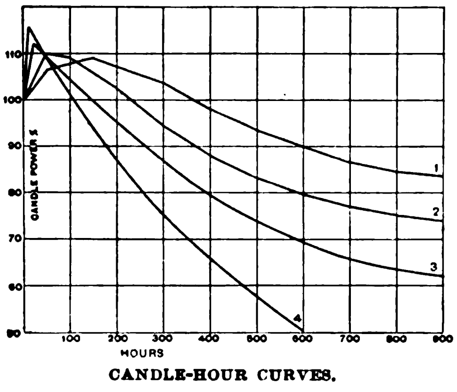
VOLTAGE, LIFE AND EFFICIENCY CURVES

589. To what extent does the voltage affect the life of an incandescent lamp?

This is shown in the following table:

Per Cent of Normal Voltage.	Life Factor.
100	1.000
101	.818
102	.631
103	.562
104	.452
105	.374
106	.310

From this it is seen that the life of the lamp is halved by an increase of 3 per cent and is reduced two-thirds by an increase of 6 per cent.



CANDLE-HOUR CURVES.

590. How are the candle-power and efficiency of the lamp affected by variations of voltage?

This is shown in the following table published by the General Electric Company:

Per Cent Voltage. Normal	Per Cent Candle-power. of Normal	Efficiency. in Watts per Candle.
90	53	4.68
91	57	4.46
92	61	4.26
93	65	4.1
94	69.5	3.92
95	74	3.76
96	79	3.6
97	84	3.45
98	89	3.34
99	94.5	3.22
100	100	3.1
101	106	2.99
102	112	2.9
103	118	2.8
104	124.5	2.7
105	131.5	2.62
106	138.5	2.54

A lamp for 16 candle-power, with 3.1 watts at 105 volts, will give 89 per cent of the light, or 14½ candle-power, at 98 per cent of normal voltage, or 103 volts, taking 3.34 watts per candle.

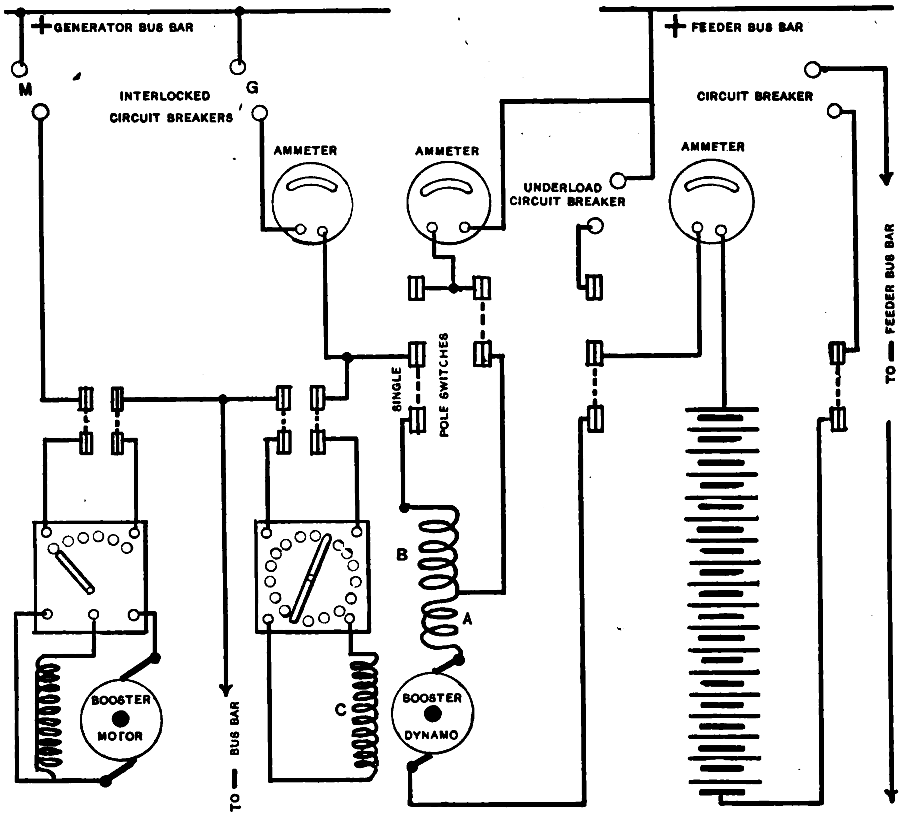
591. What is meant by the "smashing point" of an incandescent lamp?

As a lamp becomes old its candle-power and efficiency drop off, so that after a certain point it becomes cheaper to throw the lamp away or to smash it and get a new lamp than to continue burning the old one. This point is called the "smashing point" of the lamp, and it varies as explained in No. 588.

592 How does the candle-power of an incandescent lamp vary with age?

The candle-power generally increases for a time and then begins to fall, reaching the initial value at about one hundred hours. The rate at which the candle-power falls varies with lamps of different makers and also with different lamps from the same factory. As the efficiency rises the candle-power falls off more rapidly. The accompanying diagram shows results of careful experiments with an excellent lamp, curve 1 showing the percentage of original candle-power after burning various lengths of time when started at an efficiency of 4 watts per candle and kept constantly at the same voltage; curve 2 shows a similar lamp started at an efficiency of 3.5 watts per candle; curves 3 and 4 show similar lamps started at 3 and 2.5 watts per candle.

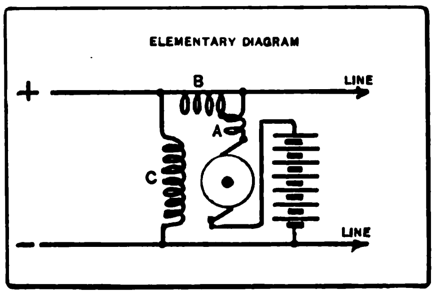
BOOSTERS AND STORAGE BATTERIES

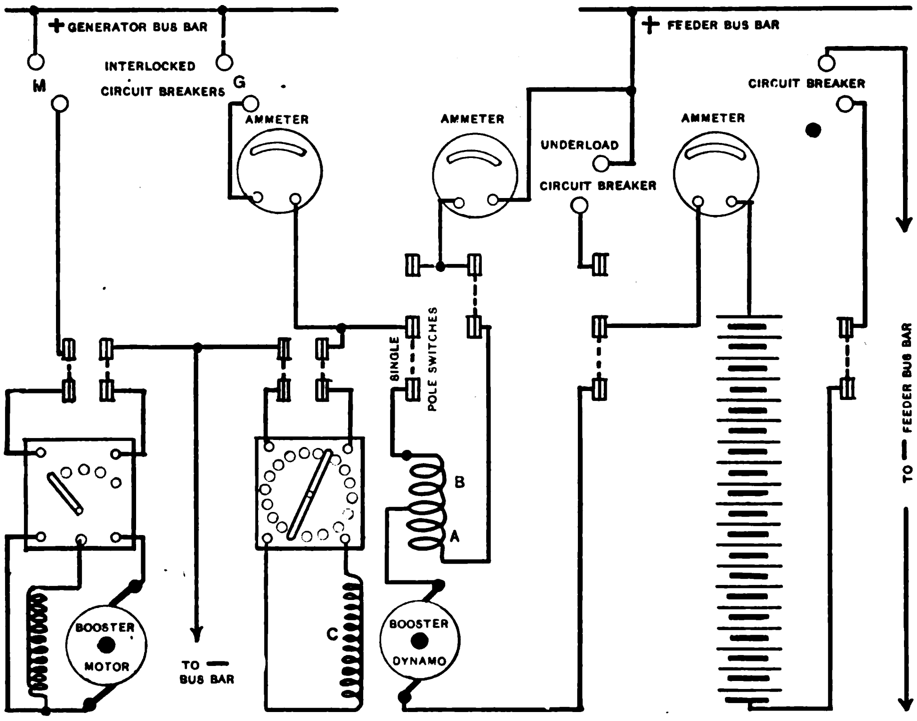


Modified Compound Booster.

The circuit-breakers, M and G, are interlocking, so that when the motor circuit-breaker, M, goes out, it trips the dynamo circuit-breaker, G.

The series coil, A, and shunt coil, C, assist the charging current; the coil, B, assists the discharge of the battery.

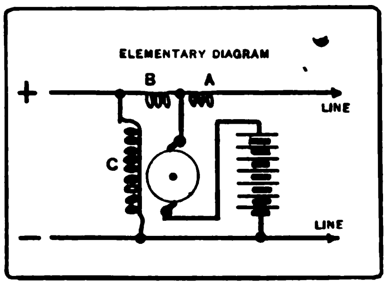




Differential Booster.

The circuit-breakers, M and G, are interlocking, as explained above.

The series windings, A and B, assist the discharge of the battery. The shunt winding of the booster tends to assist the charging current.



Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

How can I magnetize a permanent magnet with alternating current? (2). What kind of steel should be used in the magnet?
T. L. H.

It is not possible. (2). Tungsten steel is the best, but a good quality of tool steel properly tempered will answer.

Is it possible to supply 300 incandescent lamps from a 110-volt dynamo, the lamps to be 1⅛ miles from the station? J. M.

It is possible but not commercially practical.

Is the difference in phase between the primary and secondary e.m.f. of a transformer 90° or 180°? B. E. L.

It is not quite 180°, but so near it that this figure is usually taken as the difference in phase.

How much current will a 20-volt 2-c.p. lamp take? (2). How much power is required to drive a 20-volt shunt-wound dynamo of 40 watts? E. S. L.

About 0.3 ampere. (2). This depends upon the efficiency of the machine; one of average efficiency would require about 0.1 horse-power.

How can I use a 5-volt dental lamp, requiring 1 to 1½ amperes, on a 113-volt alternating circuit? R. M. W.

Connect the lamp in series with a parallel group of three 16-c.p. 110-volt lamps. If this gives too much current in the dental lamp, switch out one of the 16-c.p. lamps or substitute an 8-c.p. lamp for it.

Will a 60-cycle 100-volt induction fan motor run on a 104-volt or 110-volt circuit of the same frequency? (2). What is the difference between an ampere-hour and an ordinary hour of 60 minutes? C. W. F.

Yes. (2). An ampere-hour is a compound unit, involving both time and current; 10 amperes supplied for two hours would be 20 ampere-hours, 4 amperes supplied for 5 hours would also be 20 ampere-hours, and so on.

Can I reverse the direction of rotation of an ordinary direct-current arc dynamo; if so, what changes will be necessary?
G. W. C.

Yes; exchange the flexible wires leading to the brush-holders, and turn the brushes around so that they will trail in the opposite direction.

In rewinding an armature does it make any difference if the pitch of the coil is reduced from 24 to 23 slots, the commutator connection being unchanged? J. A. P.

Theoretically there would be a slight increase in the speed of the armature, but practically there is no appreciable difference.

I have three 6-in. electric bells connected in series to be operated by a single push button, but they do not ring well. What is the proper method of connection? L. A. V.

The three bells can be operated in series if the vibrators of two of them be short-circuited and three times the number of battery cells be used that you would use for a single bell. Any reasonable number of bells may be operated in series by short-circuiting the vibrators of all of the bells except one.

Can I charge 10 cells of storage battery from a 20-volt dynamo? (2). How many amperes will a 20-volt 16-c.p. lamp require?
C. H. S.

Yes, by speeding the dynamo up until its e.m.f. is about 23 volts. (2). This depends upon the efficiency of the lamp; a lamp of average efficiency will require about 2½ amperes.

Why is a motor rated differently when it is enclosed from the rating than when it is open at the ends? J. H. M.

Because when the ends are open air can circulate freely through the motor and carry away much of the heat, whereas when it is enclosed there is no ventilation and the heat must be radiated from the surface of the shell; consequently, an enclosed motor will reach its temperature limit with a smaller load than one which is ventilated.

Please give formulas for the draw-bar pull required by an electric locomotive to draw a train on a level track and on a grade.
J. M. S.

The draw-bar pull in pounds of an electric locomotive on a level track is given by the formula: $0.00000294 \times V^2 \times W$, in which "V" is the velocity of the train in feet per second, and "W" is the weight of the train in pounds. The additional pull due to a grade is equal to $0.0002 \times W \times G$, in which "W" is the weight of the train, and "G" is the grade in feet per mile.

What is the rate of electrodeposition of zinc and that of copper? C. L. C.

Zinc is deposited at the rate of 0.0463 oz. per ampere-hour; cupric copper is deposited at the rate of 0.0415 oz., and cuprous copper at the rate of 0.083 oz. per ampere-hour.

How can I make a spot for a Bunsen photometer? F. D. R.

The best way is to let a drop of melted paraffine fall on heavy absorbent paper and keep the paper warm until the paraffine has all soaked in.

What units do the divisions on a Warner pocket battery gauge represent? A. H.

The divisions are merely degrees of a circle. A battery gauge is not a current meter; it merely serves to compare the strength of two batteries and not to indicate the current or the e.m.f., although the deflection of the needle is in a sense an indication of the current strength.

In the description of the one horse-power motor published in the January 1899, number the statement is made that the resistance of the armature is one ohm, and that the normal current is 8.3 amperes. Why is not the current $\frac{110}{1} = 110$ amperes? (2). It is also stated that the field current is one-half ampere, and the size of the field wire is No. 22. Why is such a comparatively large wire necessary? (3). To what extent may magnet cores be reduced in cross-sectional area by using wrought-iron instead of cast?
A. W. P.

The current is only 8.3 amperes because the counter e.m.f. of the armature is 101.7 volts, so that only 8.3 volts are actually applied to the resistance of the winding. (2). No. 22 wire is used because the resistance of a smaller wire would be so high that not enough current would pass to magnetize the field magnet core sufficiently. (3). The cross-sectional area of a wrought-iron core may be made 4-9 of that of a cast-iron core, on the basis of average saturation for each class of material.

Is there any rule or formula for the size of wire to be used in field coils and armatures? F. P.

No; the allowable loss in the windings depends on the shape and area of the radiating surfaces and the ventilation. Ordinarily it is safe to allow a loss of 0.4 watt in a field coil for each square inch of radiating surface around the outside of the coil. In armatures it is safe to allow a loss of one watt in the winding for each square inch of armature radiating surface, provided the armature runs at a fairly high rate of speed, such as 2500 to 3000 ft. per minute.

What size of wire should a 15-kw. 110-volt bipolar dynamo be rewound with in order to convert it into a 500-volt motor? (2). What power would the motor develop? J. C. K.

Make the size of wire on both the field and the armature seven gauge numbers smaller than the present wire. Wind the field coils to exactly the same depth in inches that they now have, and put as nearly as possible 4.6 times the number of turns per armature coil that the machine now has. It will probably spark considerably at the commutator unless the number of coils is increased. It would be better, therefore, to use twice the number of coils, making the turns in each coil as nearly as possible 2.3 times the present number of turns. (2). Between 15 and 18 horse-power.

How is the flux of multipolar ring dynamo fields calculated? (2). Is the pressure applied to the crank-pin of an engine at any instant the same as the total pressure on the piston, or does the angularity of the connecting-rod make any difference? R. W.

The formula for multipolar dynamos in which ordinary multi-path armature windings are used, is:

$$\frac{100,000,000 \times E}{W \times N} = \text{flux per pole.}$$

In this formula "E" is the electromotive force generated in the armature winding, "W" is the total number of wires around the circumference of the armature, and "N" is the number of revolutions per second. When the armature has the two-path or so-called series winding, the formula is changed to:

$$\frac{200,000,000 \times E}{W \times N \times P} = \text{flux per pole,}$$

in which formula "P" represents the number of poles on the machine and the other letters have the same meanings as before. (2). When the connecting rod and crank are at right angles with each other it is sufficiently accurate to consider that the turning effort or torque on the crank is identical with the total pressure on the piston. At other positions of the crank this is not permissible. The thrust on the pin, however, is practically equal to the total piston pressure at any point; the maximum difference is within 3 per cent.

TRANSFORMERS FOR THE MANHATTAN ELEVATED.

The accompanying illustrations show the salient features of the type of transformer which will be used by the Manhattan Elevated Railroad Company for supplying current to lights on the elevated stations when the electrical equipment of the road is completed. The transformers are of the Westinghouse Company's latest "O. D." type, and are to be of 3.2 and 6.4 kilowatts output. The transformers are of the familiar shell-type which has been used by the Westinghouse Company from the inception of commercial alternating-current work.

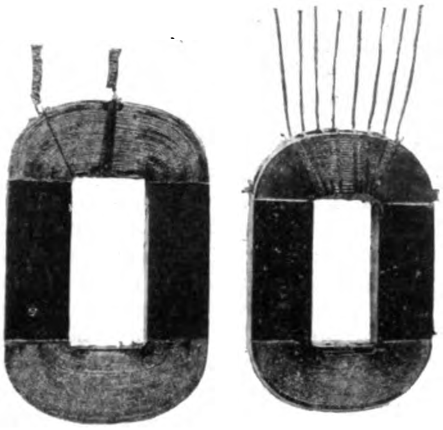


FIG. 1.—TRANSFORMER COILS.

The coils are individually insulated and are spread apart at the ends in such a way as to secure the greatest possible heat radiating surface without in any way lowering the efficiency of the apparatus. The transformers will be arranged for two primary and three secondary voltages, individual sections of the windings being supplied with terminal contacts which can be connected up to give the desired voltage. The secondary coils are wound with copper of square cross-section, which gives about 30 per cent more useful cross-section than round copper, for a given size of coil, and therefore less loss due to the resistance of the windings.

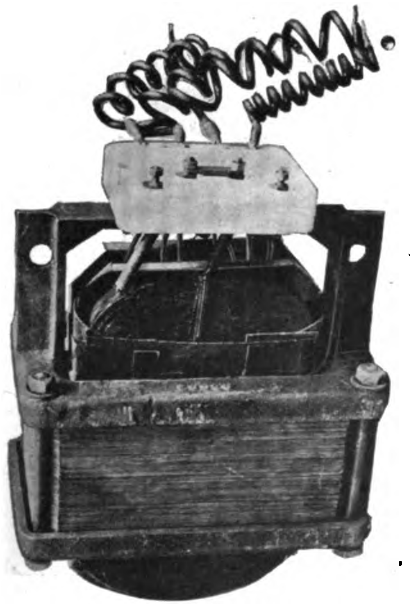


FIG. 2.—COMPLETE CORE AND COILS.

Before the "O.D." transformer was put on the market it was subjected to a series of the most thorough tests in order to remedy any possible defects in design or construction. The transformers are oil insulated and may be arranged with the Scott two-phase three-phase connections.

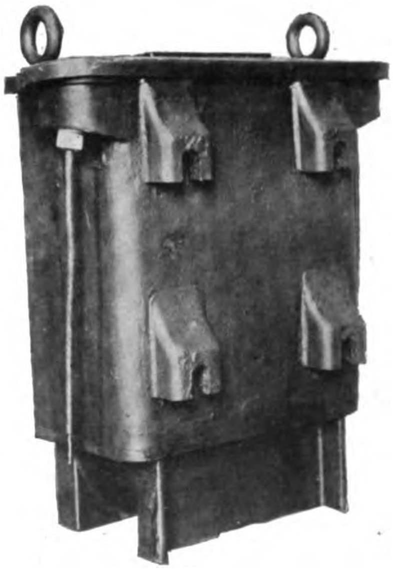


FIG. 3.—"O. D." TRANSFORMER.

◆

TEST OF A HIGH SPEED ENGINE.

The Skinner Engine Company, of Erie, Pa., was recently the recipient of an order for an engine, the acceptance of which, we are informed, involved the following guarantee: (1) The engine was to indicate 120 horse-power when running at 300 r.p.m. under a pressure of 100 lbs., cutting off at quarter stroke, and was to be capable of driving a 75-kw. dynamo at any rational overload. (2) The shaft governor was to be provided with such adjustment that the speed could be reduced 50 r.p.m. in increments of 5 revolutions, the only adjustment permitted being the addition of weights to the arms of the governor. (3) The engine must maintain the same rate of speed light or loaded at any point between the maximum and minimum. (4) The instantaneous change of speed from no load to overload (amount of overload not specified) of a 75-kw. dynamo should not exceed one per cent, the load being thrown on and off by make and break contact switch.

A 14 x 22 Skinner engine was selected to fill these requirements. The engine, we are informed, was tested by the purchaser of the engine, with the results shown by the accompanying table. The dynamo was belt-driven and the load was supplied by a rheostat. The full load was thrown upon the engine by the closing of the switch and all the readings were taken simultaneously. Figs. 1 and 2 are cards taken from tests 5 and 6, Fig. 2 showing the friction load of the engine and dynamo. The manufacturer claims that the speeds at full and no load were exactly the same. In the first test it is claimed that the engine, the nominal horse-power of which is 100, had a load of 174 i.h.p. suddenly put upon it with only a momentary checking of the speed of two revolutions.

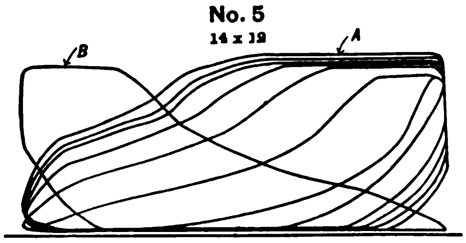
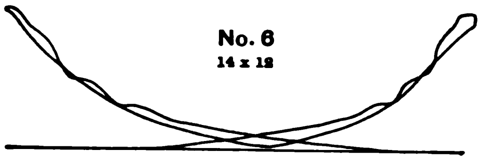


FIG. 1.—FULL LOAD DIAGRAM.



FIGS. 2.—FRICTION LOAD DIAGRAM.

Test No.	Boiler press.	R.P.M. Light	R.P.M. Loaded.	Variation. No load to full load. Up. Revs.	Up. Per ct.	Down. Revs.	Down. Per ct.	Electrical Load. Amp.	Volts.	KW.	I.H.P. Start'g load.	I.H.P. Run'g load.	Wts. on gov.
1	100	.03	303	2	.65	2	.99	250	200	50	174	80.6	0
2	105	293	293	1.5	.51	2	.68	260	240	62.4	172	98	2
3	110	288	288	3	1.04	3	1.04	250	240	60	175.5	92	4
4	106	280	279	3.5	1.26	3.5	1.26	250	240	60	173	102.5	6
5	101	274	274	2	.73	2	.73	245	230	56.35	150	94	8
6	100	268	267	2.5	.94	2.5	.94	260	250	65	150.5	99.5	10
7	103	262	262	3	1.14	3	1.14	270	255	68.85	147.5	108.5	12
8	103	257	257	3	1.16	2	.77	240	230	55.2	139	84	14
9	106	253	253	3	1.18	3	1.18	240	225	54	142	92.5	16
10	100	249	249	2.5	1.0	2.5	1.0	240	223	54	134	82	18
11	100	246	246	2	.82	2	.82	230	220	50.6	136.5	85	20

◆

A SMALL DYNAMO.

The Midget dynamo illustrated herewith is said to be one of the smallest and most complete dynamos on the market, comprising all the features of modern design. It has an output of 10 watts and is shunt wound, with a toothed drum armature and removable field coil. The pole-pieces are bored out and all the joints are tooled. It is particularly adapted for experimental purposes requiring small current and voltage, and will light a special 6-c.p. lamp, decompose water, electroplate, supply induction coils, etc. It is built by the Elbridge Electrical Manufacturing Company, of Elbridge, N. Y.

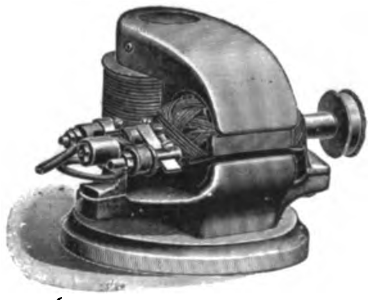


FIG. 1.—MIDGET DYNAMO.

New Apparatus and Appliances

ROBERTS FIXTURE BLOCK.

A recently patented fixture block made by the H. C. Roberts Electric Supply Company, of Philadelphia, is illustrated by Fig. 1. As shown in the engraving, the fixture block is provided with steps to fit different sizes of standard canopies. The block is neat in appearance and the advantage claimed over the old style flat surface blocks is that the canopy when once in place cannot slip sidewise, but is firmly fixed in a central position about the fixture stem. The block fits canopies of 3, 3½, 4 and 4½ inches diameter.

PALMER MARINE MOTOR

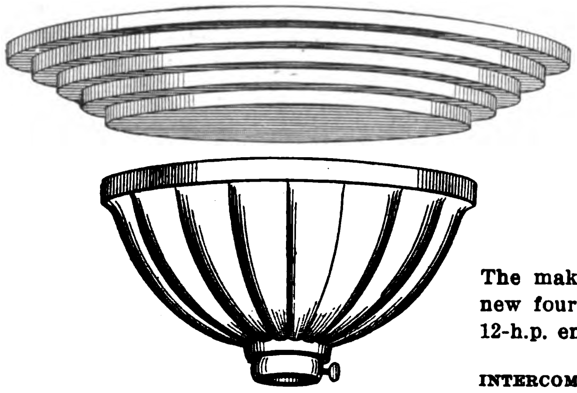


FIG. 1.—FIXTURE BLOCK.

Fig. 5 depicts a new model gasoline marine motor manufactured by Palmer Bros., of Mianus, Conn. It differs from the motors heretofore made by the same concern in having a low base by virtue of which it is claimed the vibration in the boat is greatly lessened. In the Palmer motors a valve regulates the charge from the closed crank chamber, which is compressed with the downward stroke of the piston. The vapor and air are drawn into the crank chamber by the upward stroke and throughly mixed by the motion of the crank. The ignition is by electric spark. The motors range from 1½ to 6 horsepower, and are provided with two mufflers, a gasoline tank and valve, inboard water connection, two sets of batteries, spark coil, two switches, wire, oil and grease. The makers have also lately perfected a new four-cycle double-cylinder self-oiling 12-h.p. engine.

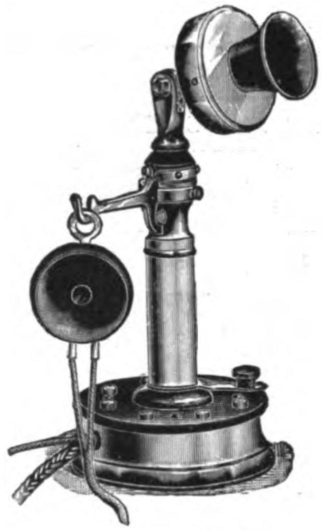


FIG. 3.—DESK OUTFIT.

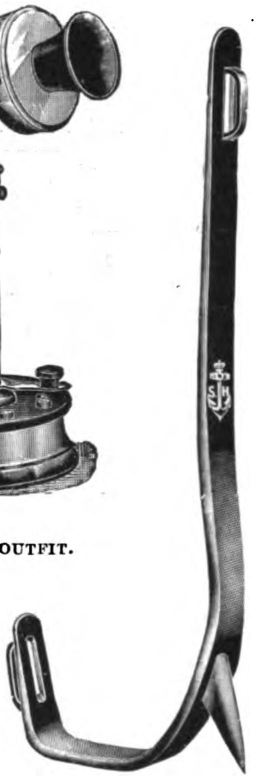


FIG. 4.—LINEMAN'S CLIMBER.

INTERCOMMUNICATING DESK TELEPHONE SET.

Fig. 3 illustrates a new intercommunicating telephone set manufactured by the Spencer Electrical Company, New York. A feature of the desk set is the location of the selective switch, which is mounted on the top of the base. The base is made of cast brass, and the top, on which are mounted the selective switch contacts and the transmitter standard, is made of a hard wood fiber. The selective switch lever is pivoted concentrically with the transmitter standard, making the arrangement very compact. The lever or key is made of spring metal, and its mounting is a ball bearing, which, while holding the lever firmly, makes it easy to swing around without necessitating holding the telephone set immovable with one hand while the other is occupied in swinging the key lever around. The under side of the selective switch is easily accessible as the cast-brass base is hollow. The selective switch is employed only for calling up another station and does not require to be returned to any particular position when the conversation is finished. All of the metal parts of the outfit are substantially nickel-plated and handsomely polished. The system is a central-energy one, and also includes a single central induction coil for all of the telephones.

LINEMEN'S CLIMBERS.

Fig. 4 illustrates a new climber which the Smith & Hemenway Company, of New York City, is putting on the market and which is called the "Swedish Sure Grip" climber. The feature of the climber is that the spur, in addition to being welded to the upright, is also riveted. The manufacturer claims that the experience gained in the manufacture and testing of the climbers warrant the guarantee of every climber turned out. The spur, it is stated, is there to stay, and it is practically impossible to knock it out.

HEAVY DUTY CORLISS ENGINES.

The illustration herewith shows two heavy duty high-speed Vilter-Corliss engines, direct-connected to electric generators at the Menger Hotel, San Antonio, Texas. The engines are operated non-condensing under 100 lbs. boiler pressure. The cylinder of the smaller engine is 13 ins. in diameter by 36 ins. stroke, and the larger one is 14 ins. by 36 ins. Each engine drives two General Electric multipolar generators of 50 kilowatts and 37½ kilowatts respectively; the smaller engine maintaining a speed of 120 r.p.m.,

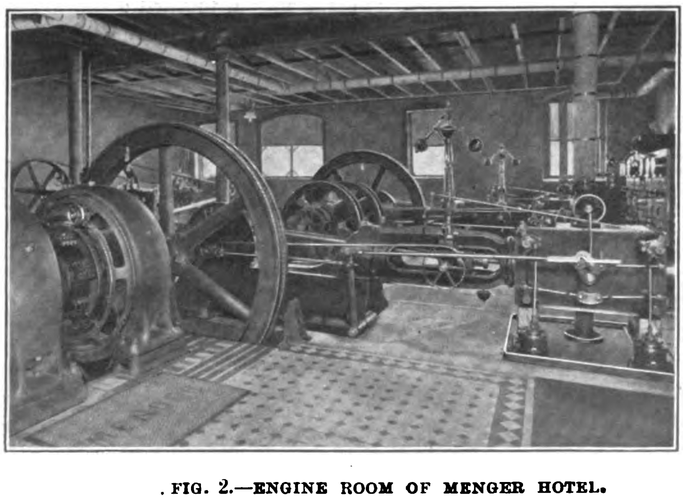


FIG. 2.—ENGINE ROOM OF MENGER HOTEL.

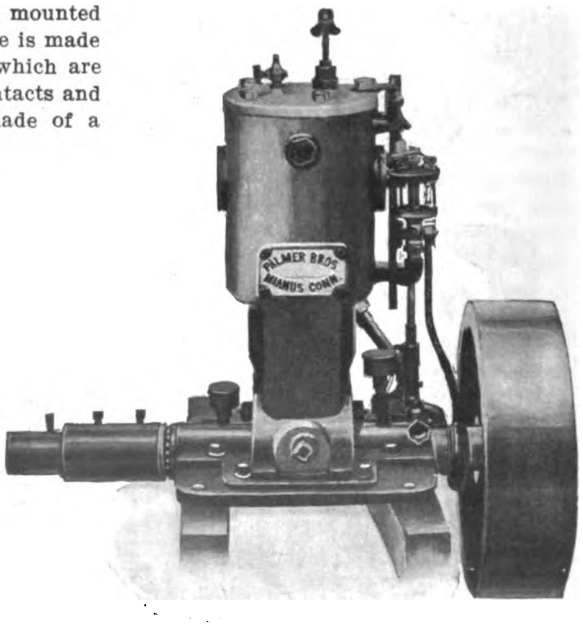


FIG. 5.—NEW MODEL MARINE MOTOR.

and the larger engine running at 125 r.p.m. The generators deliver current at 125 volts for 1000 incandescent lamps, 20 arc lamps, 60 ceiling fans and a number of motors used for various purposes. Both engines are supplied with heavy-duty frames and are specially designed for the particular class of work performed. The valve gear is of the hook release type, while the dash-pots are said to operate noiselessly, and being entirely enclosed are consequently dust-proof. The engine room, of which Fig. 2 represents only a part, is also provided with two 6-ton Vilter ice-making machines, each driven by a 10 x 24 Vilter-Corliss engine. The Vilter Manufacturing Company, of Milwaukee, the builder of these engines, makes a specialty of Corliss engines for electric light and power work, and also of refrigerating and ice-making machines.

SCREW-CUTTING ENGINE LATHES.

Fig. 6 illustrates the "Star" screw-cutting engine lathe made by the Seneca Falls Manufacturing Company, of Seneca Falls, N. Y. These lathes are said to have important and unique advantages over other lathes of corresponding sizes. They are furnished with end thrust ball-bearing spindles, automatic cross feed, plain or compound rests, U. S. standard, Whitworth or metric lead screws, together with taper drawing-in chuck and gear-cutting and milling attachments when desired. A patent foot power is provided which, it is claimed, enables the operator to accomplish more work with less fatigue than any other form. It consists of double treadles with a walking motion; the treadles are movable and work independently of each other, each being connected at opposite ends of a driving-wheel shaft in such a manner as to produce a strong, positive and continuous rotary effort. The rack, small gears and all working screws are made from steel, and all the small parts liable to be bruised are case-hardened. The head-stock, which is strong and heavy, has a hollow spindle of crucible steel, and runs in phosphor-bronze bearings. The tail-stock has a steel spindle provided with a self-discharging center, and an improved locking device which is said to insure perfect alignment. The other parts of the lathe are clearly shown in the engraving. Its actual swing is 10 and 12 inches.

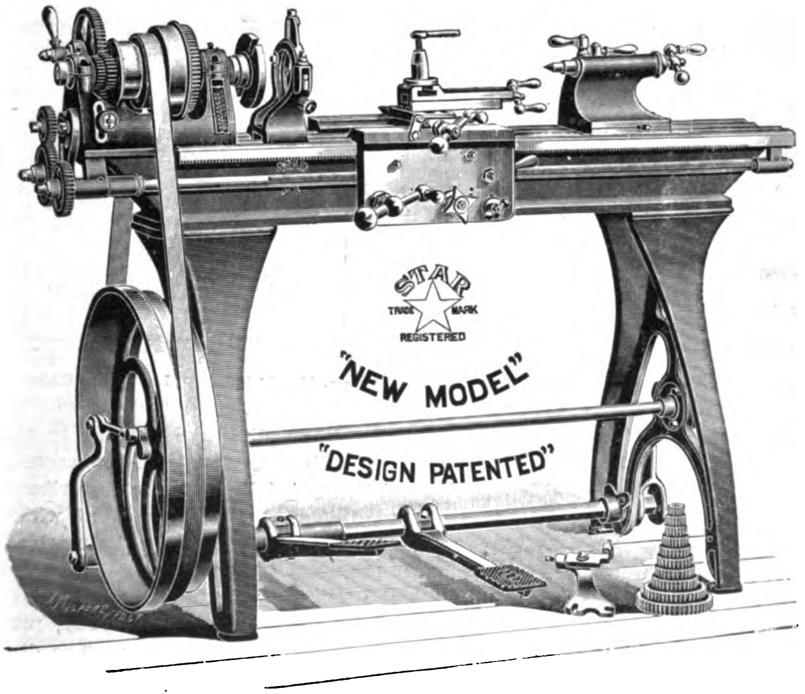


FIG. 6.—SCREW CUTTING ENGINE LATHE

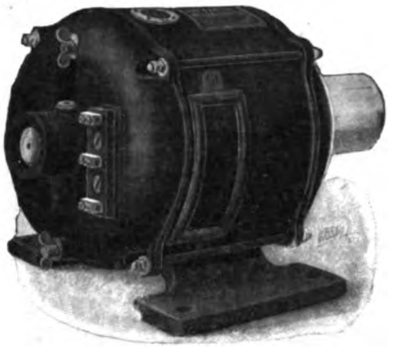


FIG. 7.—DIRECT-CURRENT MOTOR.

NEW DIRECT-CURRENT POWER MOTORS

The accompanying illustration shows a new direct-current power motor built by the Emerson Electric Manufacturing Company, of St. Louis, and which embodies several new features. In both mechanical and electrical design it resembles large engine-type generators. The armature and commutator are mounted upon the same casting, thereby permitting the shaft to be removed without disturbing their relative positions. The armature is, of course, laminated and a straight line type of brush holder is used which is claimed to be both simple and reliable. The motor has six poles and the field magnet is built up of sheet iron stampings, as in induction motors. The motors are entirely enclosed, the commutator end of the case being provided with two small covers, the removal of which gives access to the brushes and brush-holders. A peephole covered with mica is provided in the top of the motor through which the commutator can be plainly seen and any sparking detected. Each motor is tested before delivery and is required to carry a 50 per cent overload.

ENCLOSED NATURAL DRAFT COOLING TOWERS.

In its first designs of Barnard cooling towers the Wheeler Condenser & Engineering Company, of New York, used a power-driven fan to supply currents of air for reducing the temperature of the water; but recently the fan was dispensed with entirely and the water cooled by trickling over meshes of galvanized iron wire, the surface of which was exposed to the atmosphere. The company is now offering a development of this latter type in the form of galvanized wire mats inclosed in a steel case and having a steel flue reaching 75 to 100 ft. above the ground, thereby permitting a strong draught of cool air to pass over the surfaces of the mats at all times. This chimney design, shown by Fig. 8, requires but little space and is very light in weight, besides possessing an additional advantage of getting rid of any vapors rising from the circulating water. The mats in the new form of tower are practically the same as those supplied in the previous de-

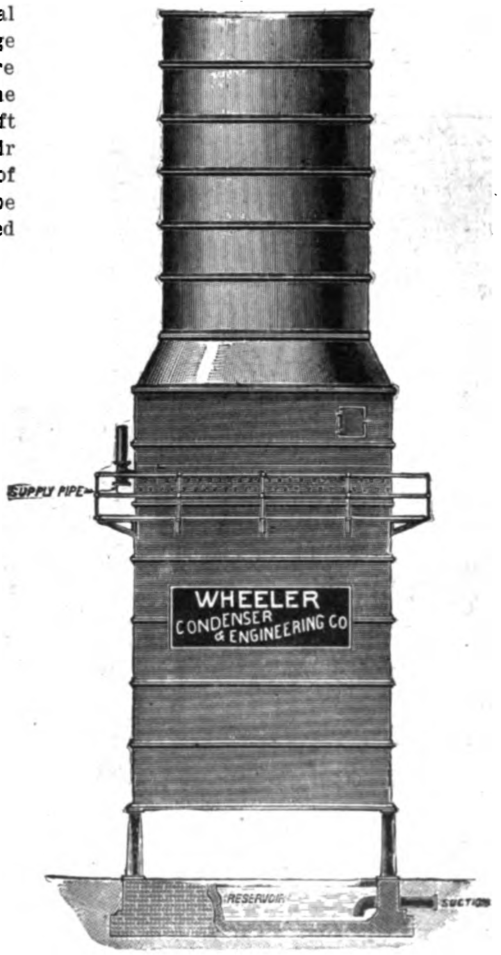


FIG. 8 —WATER COOLING TOWER.

sign of Barnard cooling towers and consist of galvanized wire woven into mats of small meshes, over which a thin film of water passes, so that each drop of water is brought into contact with the circulating air, causing a rapid and positive lowering of the temperature.

MECHANICAL TUBE CLEANER.

The illustration herewith (Fig. 9) represents the Weinland Mechanical Tube Cleaner in operation on a 350-h.p. B. & W. boiler at the Edison Electric Light Station, Columbus, Ohio. The boiler in question has 168 four-inch tubes each 18 ft. long, and the cleaner clears them of scale at the rate of seven an hour; a 3-h.p. motor drives the cleaner head at 1500 r.p.m. The Lagonda Manufacturing Company, of Springfield, Ohio, the maker of the cleaner, states that it can be easily and quickly attached to the boiler front, and changed from tube to tube very rapidly. The rapidity with which the cleaner will perform its work is of course governed by the thickness and hardness of the scale, but the manufacturer is of the opinion that the conditions met with at Columbus are about the average. Two men are required to manipulate the apparatus, one at the machine and the other at the motor rheostat and switches.

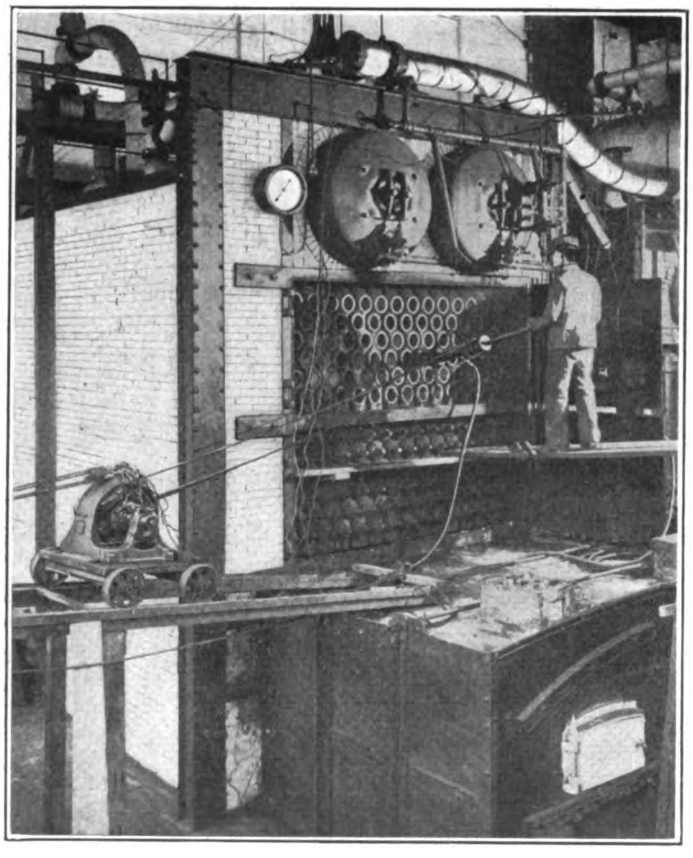


FIG. 9.—MECHANICAL TUBE CLEANER AT WORK.

A NEW ENCLOSED MOTOR.

Fig. 10, herewith, illustrates a motor built by Palmer & Olson, New York which embodies several notable features. As will be seen from the illustration, the motor is almost entirely enclosed, and is adapted for either floor or ceiling work. The magnet is a single casting of soft steel, provided with ventilating slots at the pulley end, and an opening at the commutator end large enough to admit the armature. The rear bearing shell is cast integral with the magnet, and the front bearing yoke is bolted to the frame and is provided with an aperture which exposes the upper part of the commutator and renders the brushes and brush-holders easily accessible. The motors are built for slow speed and are said to run noiselessly. The bearings are self-oiling, of course. The advantages claimed by the makers are that the machines are interchangeable for floor or ceiling work; that they run under full load without any perceptible increase in temperature; the brushes are self-adjusting, and the machines show no external magnetism. Their spheroidal contour also renders them less liable to accident from external causes.

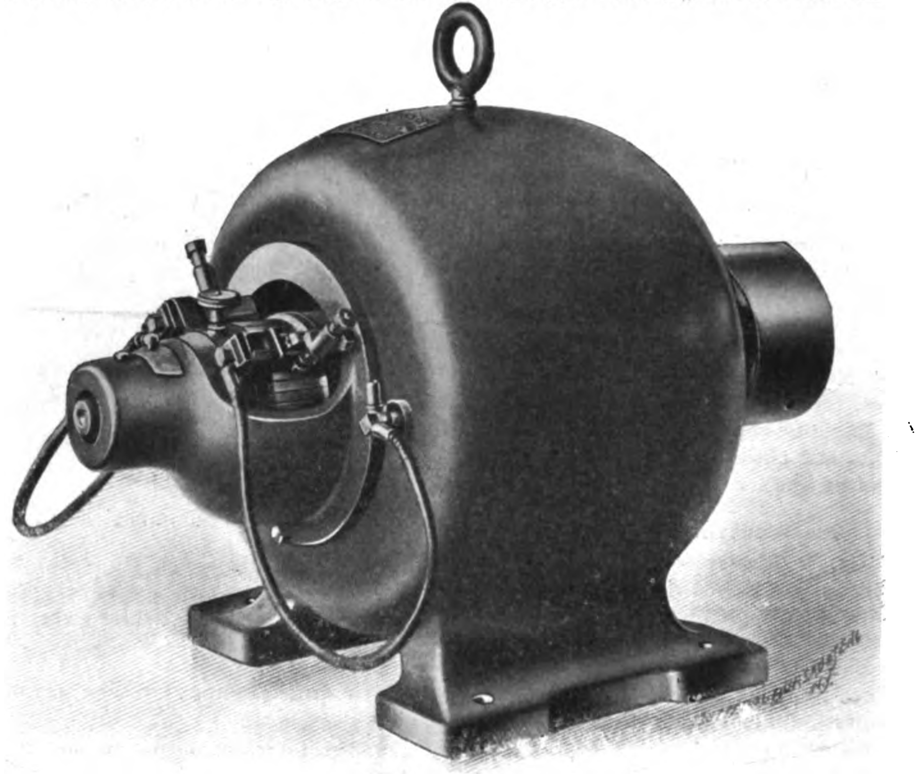


FIG. 10.—SEMI-ENCLOSED MOTOR.

THE STANDARD HOWLER

Fig. 11 is a diagram showing the application of an ingenious device which is original with the Standard Construction Company, of Chicago, and the function of which is to enable the exchange operator to call up a subscriber who has left his receiver off the hook. It is known as the "howler," and consists of a vigorous buzzer or vibrator and a repeating coil, connecting as shown by the diagram. When the exchange operator inserts the plug in a subscriber's line jack and presses the key shown to the right, the buzzer vibrates rapidly, interrupting the current in the primary of the repeating coil. The secondary of the coil delivers to the subscriber's line a rapidly alternating current which produces a howling noise in the receiver, hence the name of the device. It is stated that the noise in the subscriber's receiver can be heard at least 100 ft. away, presumably in quiet surroundings. The diagram shows the "howler" or vibrator separate from the repeating coil, but the actual apparatus is made with both vibrator and repeating coil enclosed in a solid oak box 15 x 16 ins.; the case is provided with four terminals to which the circuit wires are attached.

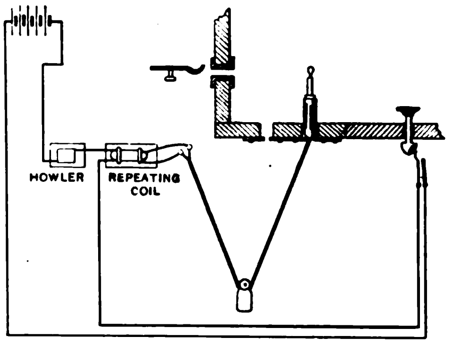


FIG. 11.—STANDARD HOWLER DIAGRAM.

The "howler" here described can, by

slightly modifying the connections, be also used as a busy back signal. Each winding of the repeating coil is divided into two separate coils, so that either the primary or the secondary coils, or both, may be connected in series or in multiple, thus giving four different combinations and three ratios.

LEGAL NOTES.

TROLLEY CONTACT SPRING.—In the suit of the General Electric Company vs. Lorain Steel Company for infringement of the Anderson patent, No. 412,155, Judge Lacombe, of the United States Circuit Court for the Southern District of New York, has granted a motion for a preliminary injunction against the Lorain Steel Company. The patent in question covers the use of metallic conducting brushes between the hub of the trolley wheel and the trolley fork.

RAILWAY CONTROLLER PATENTS.—The United States Circuit Court of Appeals for the second district of New York has declared invalid the Knight controller interlocking patent, No. 428,169, dated May 20, 1890. This patent covers an interlocking arrangement between the controller handle and the reverser handle, designed to prevent the operation of the reversing lever when the controller handle is in any position except that of no current. The Court also declared invalid patents No. 223,167, of August 14, 1883, and No. 401,085, of April 9, 1889, issued to Prof. Elihu Thomson, and covering respectively the application of a magnetic blowout to street railway controllers, and the application of a shield of insulating material between the opposed surfaces of the arc-rupturing device and the electrodes between which the arc is formed.

OBITUARY.

ERIC E. ERICKSON, president of the Erickson Electric Equipment Company, Boston, died at his home in Boston, February 14, after a short illness. Mr. Erickson was well known among the older members of the electrical fraternity, having been connected with various interests since 1885. In the days of the Edison Isolated Lighting Company he was connected with its Boston department. Of later years he was identified with the production of Aetna railway insulation. Three years ago he organized the Erickson Electric Equipment Company for the purpose of installing complete lighting and power plants. Mr. Erickson was fifty years of age at the time of his death.

FRANCIS O. MATTHIESSEN, president of the Weston Electrical Instrument Company, of Newark, N. J., and for several years a director of the American Sugar Refining Company, died recently in Paris. He retired from business about a year ago and had since been traveling for his health. Mr. Matthiessen was born in the Duchy of Holstein, in 1833, and came to the United States in 1859. He was a director of the Goubert Manufacturing Company, the New Jersey Street Railway Company, the Glucose Sugar Refining Company, of Chicago, and was a member of the South Side Sportsmen's Club, the New York Club, the Metropolitan Museum of Art, the Museum of Natural History, and of the New York Chamber of Commerce.

PERSONALS.

MESSRS. EUGENE GRIFFIN and W. J. CLARK, of the General Electric Company, sailed last month for Europe.

MR. H. C. MARSH, who has been connected with the Westinghouse Company's Seattle office for the past year, has been transferred to the Cincinnati office of that company.

MR. CALVERT TOWNLEY, who has been for some time manager of the Boston office of the Westinghouse Company, has been appointed general agent for that company with headquarters in New York.

MR. FRED SARGENT, the well-known electrical engineer of Chicago, was in New York last month on professional matters, and while here purchased considerable apparatus for a new plant which he has under construction.

MR. W. C. JESSUP, a graduate of the engineering school of Columbia University, has joined the forces of the Morris Electric Company, New York, and will devote special attention to the Keystone instruments which this company handles for New York.

MR. WM. B. McCURDY, manager of the New York office of the American Electric Fuse Company, Chicago, was married on March 4 to Miss Estelle M. Dwight, at the bride's home in Chicago. Mr. and Mrs. McCurdy will make their home in Brooklyn.

MR. H. C. HUTCHINSON, who was for several years general superintendent of the Cincinnati Electric Illuminating Company, has been appointed general manager of the company. Mr. W. E. Hopton, of Jersey City, has succeeded Mr. Hutchinson as general superintendent.

MESSRS. WM. C. WOODWARD and M. LOUD, of the Narragansett Electric Lighting Company, Providence, R. I., were visitors in New York City last month. Messrs. Woodward and Loud are rejoicing in the condition of their company's business, which ranks next to that of the Edison Illuminating Company of Boston.

MR. W. H. PELTON, the head of the Pelton Engineering Company, of Cleveland, Ohio, has been ill for the past few weeks as the result of a severe shock received while inspecting an arc-light plant which his company recently installed at Lakewood, Ohio. Mr. Pelton is still in a weak condition and it will probably be some little while before he resumes active work.

DR. LOUIS DUNCAN and DR. CARY T. HUTCHINSON have been appointed consulting electrical engineers to assist Chief Engineer William Barclay Parsons, of the New York City Rapid Transit Commission. Messrs. Duncan and Hutchinson will have charge of all the electrical work to be done in the tunnel now under construction in New York. Drs. Duncan and Hutchinson have been since 1891 associated in much of the important electrical engineering work that has been done. They, in conjunction with Mr. Sprague, designed and built the first large electric locomotive, in 1891, for the North American Company. They were the engineers of the Baltimore & Ohio tunnel work, completed in 1894, and which has been operating so much to the satisfaction of the Baltimore & Ohio Railroad Company that this company has now asked them to investigate the proposition of conducting their entire train service over the Allegheny Mountains by electricity. This will be one of the most extensive electric-traction problems ever undertaken.

TRADE PUBLICATIONS.

LUNDELL FAN MOTORS. Sprague Electric Company.—Catalogue No. 303, containing illustrations and descriptions of the Lundell fan motors for 1901, described in another part of this number.

FLEXIBLE METALLIC TUBING. Albanus L. Smith & Company, Philadelphia, Pa.—A new catalogue of flexible metallic tubing which is adapted for conveying air, steam, gas, oil or water.

LUNDELL MOTORS. Sprague Electric Company, New York.—This is Bulletin No. 205, comprising a well-illustrated catalogue of Lundell motors of both single field-coil and radial-pole types.

EXHAUST HEAD. B. F. Sturtevant Company, Boston, Mass.—A folder giving descriptions and prices of the Sturtevant exhaust head, the size of which ranges from a 1-in. exhaust pipe up to 36 ins.

DIRECT-CURRENT ARC LAMP. The Falcon Electric Manufacturing Company, New York.—Bulletin No. 7, descriptive of Falcon enclosed arc lamps for use on direct-current circuits, and known as Type A.

SELF-COOLING TRANSFORMERS. Westinghouse Electric & Manufacturing Company. —Circular No. 1040, superseding Circular No. 1010, and describing self-cooling transformers ranging in output from 10 to 500 kilowatts.

SEARCHLIGHT PROJECTORS. General Electric Company.—Bulletin No. 4241, describing a line of projectors recently brought out by the General Electric Company which includes sizes ranging from 9 to 36 ins. in diameter.

RHEOSTATS. The Simplex Electrical Company, Cambridgeport, Mass.—A catalogue describing the Simplex "unit" system of dynamo field rheostats, motor-starting rheostats, motor-controlling rheostats, and theater dimmers.

FAN MOTORS. General Electric Company. —Catalogue No. 1031, illustrating the General Electric Company's 1901 line of fan motors for alternating and direct currents. The principal members of the two lines are described elsewhere in this issue.

HOT-WIRE AMMETERS AND VOLTMETERS. Stanley Electric Manufacturing Company, Pittsfield, Mass.—This is Bulletin No. 113, superseding Bulletin 106, and describing the hot-wire instruments manufactured by the Stanley Company.

AUTOMATIC TELEPHONE SYSTEM. The Clark Automatic Telephone Switchboard Company, Providence, R. I.—A catalogue of standard size devoted to the Clark automatic telephone system, which was described in the last issue of this paper.

SWITCHBOARD AMMETERS AND VOLTMETERS. Westinghouse Electric & Manufacturing Company.—This is Circular No. 1041, superseding Circular No. 1014, and describing round-pattern ammeters and voltmeters for switchboard service on direct-current and alternating-current circuits.

CALENDAR. Seaboard Air Line Railway.—This is a belated calendar for 1901 of the hanging type, comprising a cardboard backing with a large monthly-leaf calendar pad. The upper part of the calendar is handsomely illustrated with a portrait of a little girl consulting a map on which the Seaboard Railway is prominent.

TRANSPOSITION OF TELEPHONE WIRES. Ericsson Telephone Company, New York.—This is the fifth of the Ericsson series of pamphlets containing talks on telephone matters. The present issue describes an improved method of making transpositions in telephone wires for eliminating the effects of mutual induction.

ELECTRIC LOCOMOTIVE AND CRANE CAR. Bullock Electric Manufacturing Company, Cincinnati, Ohio.—Bulletin No. 38, illustrating and describing the Bullock Company's combined electric locomotive and crane. The locomotive consists of a flat car having a small cab at one end and a jib crane mounted in the center.

ELECTRIC MINE LOCOMOTIVES. Baldwin Locomotive Works and Westinghouse Electric & Manufacturing Company.—This is a handsome catalogue of mining locomotives, containing views of the various types of locomotives built jointly by the two companies named, and also illustrations of the motors and other parts separately.

GRAPHITE AS A LUBRICANT. Joseph Dixon Crucible Company, Jersey City, N. J.—This is the seventh edition of the Dixon Company's well-known brochure on the subject of graphite used as a lubricant for steam engines and other machinery. The book contains several enthusiastic testimonials from users of graphite for this purpose.

SMALL TELEPHONE SWITCHBOARDS. Kellogg Switchboard & Supply Company, Chicago, Ill.—Bulletin No. 2, containing valuable information concerning the Kellogg line of small switchboards and particularly the express type. The bulletin is beautifully executed on plate paper, the illustrations being equal to the finest grade of magazine work.

ELDEN CIRCUIT BREAKERS. S. B. Condit, Jr., & Co., Boston, Mass.—A tastefully-executed little catalogue in which are described and illustrated Elden alternating-current and direct-current circuit-breakers of the usual type; circuit-breakers designed especially for use with composite alternators, and oil-break circuit-breakers for high-tension alternating-current circuits.

SERIES ALTERNATING-CURRENT ENCLOSED ARC SYSTEM. Manhattan General Construction Company, Newark, N. J.—Bulletin No. 114 C, descriptive of the Manhattan reactive regulating coil for maintaining constant current in a series circuit supplied from a constant-potential origin. The bulletin also describes the Manhattan series enclosed-arc lamp for use in connection with this regulator.

INTERIOR CONDUIT. Sprague Electric Company, New York.—This is Catalogue No. 404 of the well-known iron-armored, brass-armored and plain interior conduit and fittings, and also contains a description of the newer Greenfield flexible metallic conduit and fittings. The catalogue also describes the tools used for installing conduits, together with switches and fuse blocks designed for use in the conduit junction boxes.

BUSINESS NEWS.

G. E. LINTON & CO., Worcester, Mass., have removed their factory to No. 25 Hermon Street, where they have much larger quarters and better facilities.

CROSS OIL FILTERS IN AUSTRALIA.—The Deep Leeds Transmission Company, of Australia, recently installed a Cross oil filter, made by the Burt Manufacturing Company, of Akron, Ohio, in its electrical power station.

THE PHELPS COMPANY, Elmwood, Ill., manufacturer of the Hylo baby filament lamp, has established an office at 177 Summer Street, Boston, Mass., which is in charge of J. L. Russell, the company's New England manager.

THE DIEHL MANUFACTURING COMPANY, of Elizabethport, N. J., has just filed a very large order for ceiling fans and electroliers of very handsome design to be installed in the Imperial Palace on the Island of Formosa.

AMERICAN CIRCULAR LOOM COMPANY, Chelsea, Mass., will shortly remove its Western office from 141 South Clinton Street, Chicago, to 130 Jackson Boulevard, Chicago, in the Electrical Building, at the corner of Desplaines Street.

THE TUDOR BOILER COMPANY, of Cincinnati, Ohio, has commenced the construction of the Babcock & Wilcox type of boilers. This company has just sold three 300-h.p. water-tube boilers to the Chicago Iron Works at East Chicago, Ind.

STANDARD UNDERGROUND CABLE COMPANY, of Pittsburg, Pa., has removed its Boston office to the Tremont Building, Tremont and Beacon Streets. The Boston office remains under the efficient management of Mr. A. B. Saurman.

A CORRECTION.—Owing to a typographical error the torch forming the subject of the advertisement of Messrs. Clayton & Lambert, of Detroit, Mich., in the last two numbers of this paper, was designated as No. 3 instead of No. 8, the correct number. The No. 3 torch uses a pump, while the No. 8 does not.

W. H. CHAPMAN, Portland, Me., manufacturer of the well-known Chapman voltage regulator, has removed his headquarters from 163 Kennebec Street to more commodious quarters at 103 Middle Street, where improved factory facilities will enable him to promptly handle his rapidly increasing business.

NATIONAL CARBON COMPANY, Cleveland, Ohio, desires to call attention to the fact that the fire at its works, which was reported by the daily papers to have destroyed the entire works, resulted only in some damage to the company's laboratory, and has not curtailed in the slightest degree its ability to fill orders.

THE CUTLER-HAMMER MANUFACTURING COMPANY, of Milwaukee, Wis., announces that at its annual meeting recently held, all of the old officers were re-elected; the officers are: F. R. Bacon, president; F. L. Pierce, vice-president; H. H. Cutler, general manager, and J. G. Hickcox, secretary and treasurer.

"CLING-SURFACE" IN HAWAII.—The Hilo Electric Light Company, of Hilo, Hawaii, in a recent letter says: "We take pleasure in stating that Cling-Surface does all you claim for it in improving the operation of belts. At first we used too much, but since refraining for a time from using it, the belt is now running finely."

ORDERS FOR BALL ENGINES.—The Lake Erie Iron Company, Cleveland, Ohio, has recently installed an electric-power plant, the engine being of 175 horse-power, self-oiling, and built by the Ball Engine Company, Erie, Pa. The Northern Pacific Railway Company has also recently purchased from the Ball Engine Company a 150-h.p. self-oiling engine for electrical service.

GREEN FUEL ECONOMIZERS.—The Rhode Island Suburban Railway, of Providence, R. I., has contracted with the New England office of the Green Fuel Economizer Company for an equipment of economizers for 7000 horse-power of water-tube boilers. The Cambridge Electric Light Company, Cambridge, Mass., will have a Green economizer in its new modern power station.

THE WESTERN ELECTRIC COMPANY, Chicago, is receiving many favorable reports from the different plants using its alternating-current series inclosed arc-lighting system. Economy of operation, ease of management, long carbon life, reliability in action and freedom from accidental injury are some of the points which the system is said to afford under all conditions of practice.

THE UNITED STATES CARBON COMPANY, of Cleveland, Ohio, reports that its business at present is extraordinary for this time of year. Usually the demand for arc-light carbons begins to fall off about February 1, in anticipation of the longer spring days, but thus far this year there has been no decrease in the demand, which bids fair to hold up steady into the spring months.

B. F. STURTEVANT COMPANY, Boston, Mass., recently installed an interesting mechanical draft plant at the works of the Diamond Rubber Company, Akron, Ohio. Two fans are employed, and the Rubber company writes that with forced draft at one end and induced draft at the other the apparatus produces a terrific draft, enabling them to make steam with extreme rapidity.

WARREN MANUFACTURING COMPANY, Chicago, Ill., recently received, among other favorable letters, the following from Morelia, Mexico: "Please send me another can of pulley cover. It is the best thing I have run across for saving belting. I have never had a hot box since I put it on my pulleys, and run my belts very loose, taking in consideration that I run at high speed. Signed, Carlos Allen."

THE STANLEY ELECTRIC MANUFACTURING COMPANY, of Pittsfield, Mass., at its annual election of officers re-elected Dr. F. A. C. Perrine president, W. W. Gamwell treasurer, and W. Taylor secretary. Under Dr. Perrine's energetic management the affairs of the company have progressed rapidly and a very large extension of the works at Pittsfield has been found necessary, and is now being carried to completion.

GILLILAND ELECTRIC COMPANY, Adrian, Mich., manufacturer of fine cabinet work and special metal work, announces that it is obtaining a large amount of business from electrical manufacturers. The company's factory is running full time, but its

A COMMERCIAL NECESSITY.

For Sale by all Supply Houses.

Upon receipt of this coupon we will send FREE, sample stick.

Name.......................................

Address....................................

A. E.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.

50c. per Stick. $5.00 per Dozen.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO.

facilities are being increased so that within a short time it will be in a position to take care promptly of any kind of special work in the nature of electrical specialties, telephone parts, etc.

QUAKER CITY RUBBER COMPANY, Philadelphia, has received many strong testimonials to the merits of its P. P. P. rod packing, which was described in the January number of the American Electrician. This packing, it will be remembered, is composed of two wedge-shaped sections of long-wearing material, and a semi-oblong section of absorbent material, the latter serving as a retainer for the oil. The packing is made in all sizes from 3/16 in. up to 1¼ ins. by sixteenths, and up to 3 ins. by eighths.

ALBANUS L. SMITH & CO., Philadelphia, Pa., announce that the list of users of flexible metallic tubing is rapidly growing. The present list of patrons on file includes such representative concerns as the Pennsylvania Railroad, Pennsylvania Steel Company, Standard Oil Company, Philadelphia Edison Company, Wm. Cramp's Ship & Engine Building Company, Spreckels Sugar Refining Company, American Iron & Steel Manufacturing Company, Chapman Wrecking Company, and the Consolidated Gas Company, of New York.

THE MARIETTA MANUFACTURING COMPANY, of Marietta, Pa., against whom an injunction was obtained by the Diehl Manufacturing Company, prohibiting the manufacture of its Crescent ceiling fans, has just completed an agreement with the Diehl Company by which it is enabled to continue the manufacture by paying a royalty. This company is undergoing reorganization, but will push the manufacture and sale of Crescent fans to the utmost, combining the valuable features covered by the Diehl patents with those covered by its own.

THE MARINETTE IRON WORKS, of Marinette, Wis., states that it is making extensive improvements in its plant, building a 120-ft. addition to the machine shop, installing an electric crane there and large boring mills. The company is installing a Taylor gas producer, manufactured by R. D. Wood & Company, in connection with which Walworth gas engines of the company's own make will be used throughout the plant. The company is overcrowded with orders for engines, not only from the United States, but also from several foreign countries.

THE VAN DORN-ELLIOTT ELECTRICAL COMPANY, of Cleveland, has been incorporated by J. H. Van Dorn, H. H. Hodell, F. Schneider, W. A. Dutton and W. H. Elliott. Capital stock, $50,000. The new company takes over the electrical repair, armature winding and manufacturing business heretofore carried on by Van Dorn & Dutton, also the electrical repair business carried on by W. H. Elliott of that city. The gear manufacturing business carried on by Van Dorn & Dutton will be continued as heretofore under the old name. The new company will occupy a portion of the Van Dorn & Dutton plant. J. H. Van Dorn will be president.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, reports the following recent orders: One 250-kw., three-bearing, slow-speed, belted-type generator for the Laclede Gas Light Company, of St. Louis, a duplicate of the machine sold to the same concern four months ago; one 80-kw. generator for the St. Louis Coffin Company; one 80-kw. belted generator for the Mannering Electric Light Company, of Mannering, Iowa; two 60-kw. belted generators for the Carrolton Electric Company, Carrolton, Iowa; and an unusually large number of orders for small machines.

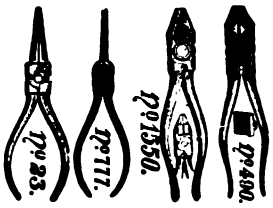
THE LEA-HOOVEN MANUFACTURING COMPANY, of Anderson, Ind., was recently absorbed by the Anderson Tool Company of the same city, which was reorganized for this purpose. This company will enter extensively into the manufacture of the well-known Lea-Hooven arc lamp, and will also continue to make the electrically-driven tool grinders which have met with such high favor. The company's facilities have been doubled within the past six months, and still further extensions are contemplated in the near future. The officers of the new company are C. A. Eastman, president, and A. G. Lea, general manager.

WEINLAND TUBE CLEANERS COMMENDED.—The Lagonda Manufacturing Company, Springfield, Ohio, recently received the following significant letter: "We have in use four water-tube boilers, and for a number of years have tried all kinds of experiments to get the scale taken out; in every case we met with total failure until by good fortune we used the Weinland tube cleaner. The machine is an absolute success for these boilers, and we most cheerfully recommend it to anyone. Scale ¾ in. thick and over has been taken from our boiler tubes." Signed, G. M. Gunderson, manager United States Brewing Company, Chicago, Ill.

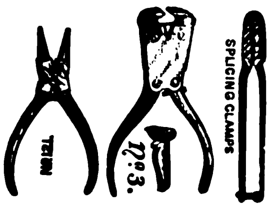
THE AMERICAN ELECTRIC FUSE COMPANY, Chicago, Ill., announces that it has more than doubled its working capacity, and has installed new and complete machinery for the purpose of turning out its well-known specialties. The company expects to place on the market in the near future important additions to its standard line of fuses, fuse boxes, lightning arresters and connectors. In addition to these specialties the company also manufactures a complete line of silk and cotton-covered magnet wire, and carries a stock of all sizes constantly on hand. The eastern office of the company is located at 116 Nassau Street, New York, and is in charge of Mr. W. B. McCurdy. This office carries in stock a full line of fuses, fuse wire, lightning arresters, wire connectors, etc. The Western office, at San Francisco, will be conducted on the same line as the Eastern office.

Telephone Service
Puts the Whole Organization of a Great City At Your Fingers' Ends Day and Night and In All Weathers.
Rates in Manhattan from $5.00 a Month.
One year contracts. Monthly payments.
NEW YORK TELEPHONE CO.
111 West 38th St. 15 Dey Street.

BIG STICK, 35 CENTS.
Sample Free.
SOUTHWORTH & HARE,
Indianapolis, Ind.


No. 23.
No. 777.
No. 1550.
No. 400.

If you want the best
see that our name is on the tool.
SMITH & HEMENWAY CO.
Utica Drop Forge & Tool Co.
296 BROADWAY, - NEW YORK.



CREAM FLUX
An Absolutely Non-Corrosive Insulating Soldering Flux FOR ALL METALS. Contains no Acid or any Element Injurious to Electric Connections. **We guarantee it. and if not satisfactory, Money will be Refunded.** You can make more than double the number of perfect connections in one half the time with CREAM FLUX than you can with the same amount of any other flux.
PUT UP IN CANS AT 15c, 25c, 45c, and 75c. SEND FOR TRIAL BOX. SPECIAL PRICES IN QUANTITY.
THIS IS WHAT ONE USER HAS TO SAY : " After having tried the various soldering salts on the market, and after giving your **CREAM FLUX** severe tests on heavy cable connections, and on the finest stranded flexible drop cord work, we can safely say it meets all claims you make for it. I consider it one of the best ever offered for sale. Yours truly, CHICAGO EDISON CO.,
Per J. H. GORAST, Constr. Supt."
Endorsed by the National Board of Fire Underwriters and all users. For sale by all supply houses or
CREAM FLUX CO., Sole Manufacturers, 909-100 Washington St., CHICAGO

PLATINUM
In Sheet or Wire, any Degree of Hardness. FOR ALL PURPOSES.
BAKER & CO.,
NEWARK, N. J.
New York Office, 120 Liberty Street.

J. HOLT GATES & CO., Chicago, have just installed a 250-h.p. electric power plant for the Grower Building, Chicago, in connection with a Vilter Corliss engine. This firm has been very busy this winter. Among other installations is one just started at the village of Blue Island, Ill., which includes a 2500-light Warren inductor alternator with a new style four-valve Ideal self-oiling engine. The series alternating-arc system of the Manhattan General Construction Company, consisting of two 25-light regulators and two 15-kw. step-up transformers, was also installed, together with a large number of 50-c.p. incandescent lamps in series with the arc lamps. Messrs. Gates & Co. have also installed for the municipality of Newberry, Mich., a 1200-light Warren inductor alternator direct-connected to an Erie Ball engine running at 300 r.p.m. A prominent feature of this plant is that there is not an oil cup on the outfit, and it is almost entirely automatic.

OLDS MOTOR WORKS, Detroit and Lansing, Mich., suffered a loss of about two-thirds of the Detroit plant by fire on March 9. The company has secured temporary quarters, however, in which new machinery has been already installed, and is now in a position to take orders for Olds mobile gasoline runabouts for May delivery. The Lansing plant will take care of the company's gasoline engine business by running night and day, so that all orders will be filled with the usual promptness. The temporary plant in Detroit already has a capacity of 10 complete gasoline runabouts a day, and will have caught up with its orders by May 1. The fire was not caused by an explosion of gasoline, as some of the papers stated; there was no gasoline stored in the building. The explosions heard during the fire were from the carbonic-acid gas tanks used in inflating tires. The origin of the fire was a leakage in the natural-gas pipes, which opened a 3-in. main into the center of the building; this fact explains the rapidity with which the fire progressed.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, of Cincinnati, Ohio, is enjoying a fine export trade in addition to its home business. Among recent sales abroad were these: Glasgow (Scotland) Evening News, three motor-generators; London Daily Express, three motor-generators; Montreal Water & Power Co., one 400-h.p. three-phase motor; Aberdeen (Scotland) Journal, one 30-h.p. teaser equipment and one motor-generator. Among domestic orders were the following: Carnegie Steel Company, one 25-h.p. type "H" motor; Greuner & Co., Johnstown, Pa., one 30-kw. type "I" generator; Brown & Sharpe, four type "N" motors for direct connection to machine tools; Wier Frog Company, Cincinnati, Ohio, three 10-h.p. type "N" motors; Pullman Company, two 150-kw. type "H" generators; Mosler Safe Company, Hamilton, Ohio, one 50-h.p. type "H" motor; Susquehanna Valley Electric Company, Sidney, N. Y., one 65-kw. single-phase generator; Central Lard Company, New York, one 65-kw. engine-type generator; Buffalo Evening News, one 70-h.p. type "H" motor.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., reports the following recent sales of direct-connected generators: Schwartzschild & Sulzberger, two 250-kw. United States Mint, Philadelphia, two 200-kw., one 150-kw., one 75-kw.; Brown Shoe Co., St. Louis, one 200-kw.; Hahne & Co., Newark. N. J., two 200-kw., one 100-kw.; E. I. DuPont de Nemours, Wilmington, Del., one 200-kw.; Navy Yard, Washington, D. C., two 150-kw.; National Electric Supply Co., Washington, D. C., one 50-kw.; Bement, Miles & Co., Philadelphia, Pa., one 50-kw.; Toledo Bridge Co., Toledo, Ohio, one 50-kw.; White Star Line, one 50-kw. In addition to these, the following motors have been sold: Philadelphia Engineering Works, 46 motors aggregating over 700 horse-power and making upwards of 3000 horse-power sold to that company; Pencoyd Iron Works, 4 motors aggregating 60 horse-power and making over 4000 horse-power sold to them; Schwartzschild & Sulzberger, two 75-h.p., two 50-h.p., seven 25-h.p., 14 motors aggregating 160 horse-power in addition to 500 horse-power already sold to them.

THE PELTON WATER WHEEL COMPANY, San Francisco, recently furnished equipment for plants as follows: Keswick Electric Power Company, California, head, 1200 ft., three units of 1600 horse-power each, for electric transmission; British Columbia Electric Railway Company, Victoria, B. C., (second station), head 700 ft., one unit of 900 horse-power for electric transmission and lighting; Big Creek Power Company, California, head 920 ft., 900 horse-power, driving two generators for power and light (second station); 100-h.p. plant for Pigeon Bay, New Zealand, operating an electric-light generator; 75-h.p. installation for a tea estate in Java, electric-light plant; 2000-h.p. unit under 500-ft. head, for electric-transmission plant in Colorado; 150-h.p. wheel, 250-ft. head, operating flour mill and electric-light plant in Utah; 75-h.p. wheel, 400-ft. head, operating electric-light plant in Borneo; 50-h.p. wheel, running generator for mine in Idaho; double unit of 250-h.p. capacity, electric transmission plant near Auburn, Cal.; 30-h.p. wheel, electric-lighting plant, Apia, Samoa; 30-h.p. wheel and transmission machinery for electric-light plant, Guatemala; 30-h.p. wheel for electric lighting, Sydney, N. S. W., and a 6-ft. wheel, 200 horse-power, for a silk mill in Japan.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, has found it necessary to open a sales office at San Francisco in order to take care of the increasing volume of business from the Pacific Coast states and the extreme western territories. This office is located in the Nevada Block and is in charge of Mr. R. B. Daggett, who has for a long period been connected with the company's staff of engineers at the Philadelphia office; his experience gained there will enable him to handle the different problems of modern storage-battery practice arising in this district.with skill and promptness. The company has recently closed a contract with the United Electric Light & Power Company, of Baltimore, for the installation of a battery of "Chloride" accumulators, consisting of 132 elements, having a capacity of 1200 ampere-hours, and with tanks allowing an ultimate increase by additional plates, to a capacity of 2100 ampere-hours. The location of the battery is 5000 ft. from the power house and it is to be operated in connection with two boosters having a capacity of 500 amperes at 35 volts. The current is furnished from the power house at 220 volts, and as it is intended to use 110-volt lamps and 220-volt elevator motors, a third wire will be taken from the center of the battery to form the neutral of 220-volt three-wire system. The two constant-current boosters will be used on the outside wires for regulating the elevator load. Another notable contract recently closed is one for the installation of a battery of Chloride accumulators for the estate of Henry Villard at Dobbs Ferry, N. Y. The battery is to be used for residence lighting, and consists of 68 elements, having a rating of 280 ampere-hours at normal discharge, and will be operated in connection with two 12½-kw. dynamos driven by two 20-h.p. gasoline engines. For ordinary requirements the battery will be charged during the day and will carry all the lighting load, but on special occasions will be operated in parallel with the dynamos.

SOLID TRAINS TO NORTHERN MICHIGAN.

The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

Greatest Fuel Saver on Record.

THE
MASON HYDRAULIC
DAMPER REGULATOR.

Will control one boiler or a battery. Guaranteed to change the damper on the slightest variation in steam pressure.

SIMPLE,
POWERFUL,
RELIABLE.

MANUFACTURED BY

THE MASON REGULATOR CO.,
6 OLIVER ST., BOSTON, MASS.

$12.00 per 1-2 Doz.

INCLUDING NICKEL DISPLAY STAND.

Extra Batteries, wholesale, 25 cts. Will keep in stock 3 months. Sample to dealers prepaid on receipt of $2.00.

COMEAD SEARCH LIGHT.

You can pick it up at any time and by simply pressing the button light up any object within fifty feet. Each battery can be used several hundred times. New batteries 35c. Easily inserted. If your dealer does not carry it, send $3.00 to

COMEAD MFG. CO., Buffalo, N. Y.

American Electrician.

Vol. XIII. New York, May, 1901. No. 5.

A COMBINED ELECTRIC LIGHTING AND STEAM HEATING PLANT.

INCANDESCENT AND ARC LAMPS AND STEAM RADIATORS SUPPLIED FROM ONE POWER HOUSE.

BY W. N. ZURFLUH.

The plant which is here described was originally designed to light and heat two business buildings in Springfield, Ohio—namely, the Arcade Building and the Press-Republic printing establishment. The plant has since been enlarged, however, to take care of some commercial lighting in the business part of the city. The ordinary direct-current system is used, with a circuit e.m.f. of 110 volts. The plant is located near the center of the city, and is just in the rear of the new Kelly Building, occupied by the Springfield Publishing Company. The building is of dark-red brick laid in red mortar with limestone foundations and free stone trimmings and water table. Its length is 102 ft., width 49 ft., and the side walls are 18 ft. high. The foundations are heavy for so low a building, being 36 ins. thick for the side and middle walls under the engine room. In the boiler room they are 24 ins. thick in the side walls; both end walls are 18 ins. thick. The brick walls are 17 ins. thick and have 22-in. buttresses for the roof trusses. The ends of the building have been closed in with wooden walls, so as to provide for future extensions with small expense.

The engine room site was excavated to the same grade as the boiler room and the floor placed so as to provide 6 ft. of space beneath it for exhaust steam pipes and dynamo connections. This floor is supported on Georgia pine beams 12 ins. square, the ends of which rest on the side walls and engine foundations. On these beams and at right angles 12-in. x 6-in. joists are placed on which the first floor of matched pine 2⅝ ins. thick is laid and finally a hard maple finishing floor ⅞ in. thick on top of this. The manner of placing the generating units allows the plant to be duplicated without disturbing the present installation. The end walls are framed with pine studding and are covered with ⅞-in. beaded pine flooring, both inside and outside. The roof is supported by the dividing wall between the engine and boiler rooms, and six steel trusses which are held together by nine pine purlines bolted to them. The roof sheeting is matched pine strips 2⅝ ins. thick and 6 ins. wide, on which the Scott's old-style tin roofing is fastened. This is laid on rosin-sized paper and is ridged with a double pressed ¾-in. ridge. Two skylights of hammered glass are placed in the east side of the roof, one each for the engine and boiler rooms. These supply light for the eastern side of the house, as no windows nor doors open on that side. A cement floor is laid in the boiler room.

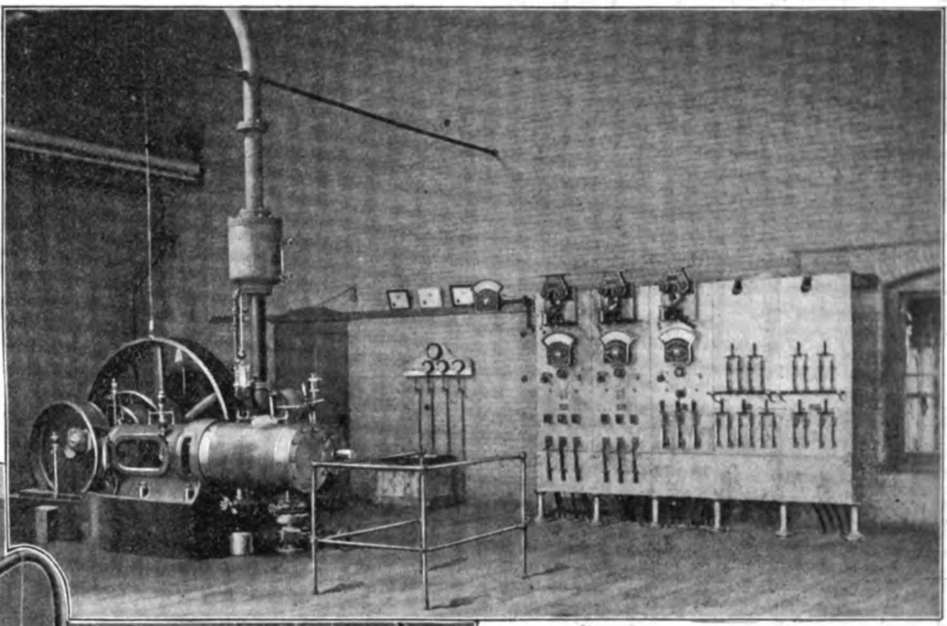


FIG. 2.—VIEW OF SWITCHBOARD.

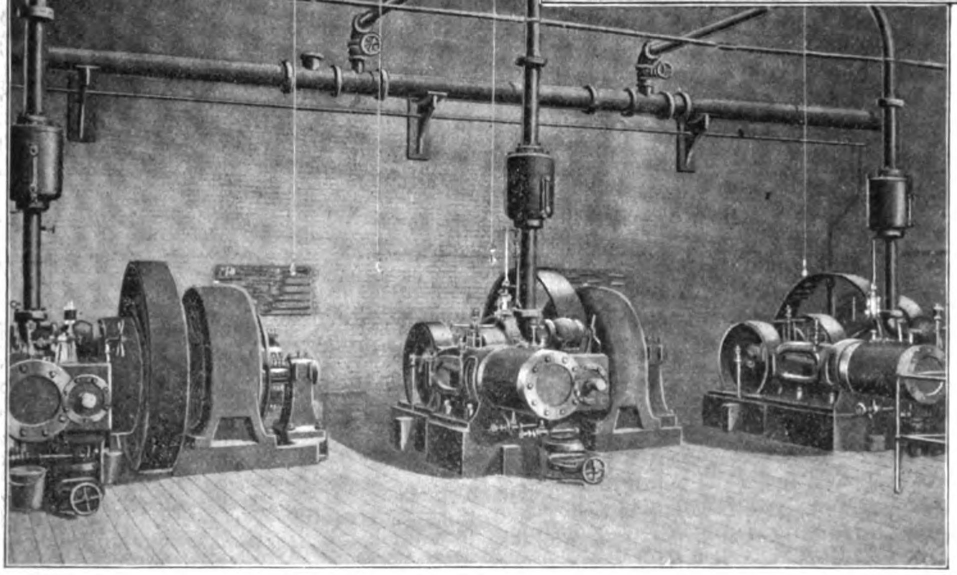


FIG. 1.—VIEW OF ONE END OF ENGINE ROOM.

There are at present two boilers of the B. & W. water-tube type, built by the Aultman & Taylor Manufacturing Company, Mansfield, Ohio. They have a combined capacity of 400 horse-power. Each boiler has two steam drums 23 ft. 3⅝ ins. long by 36 ins. in diameter, each drum being connected to 10 tube-sections. They are hung in the usual manner and were tested to a pressure of 190 lbs. per square inch before being bricked in. The steam pressure carried is 120 lbs. The fronts are the usual standard full-flush design as to the upper parts, but the lower parts were designed and installed by the stoker builders. The usual iron water columns and brass pipe fittings are provided. An accident worth mentioning occurred to one of the water columns on the first night the plant was in operation. It is common practice to mount the water columns without providing valves between the steam drums and the columns. As such valves were not specified in the contract, they had been omitted by the erector against the protest of the present writer. During the early evening of the first night the plant was in operation the drain pipe at the bottom of one of the water columns blew out, taking the screw-thread with it, and as there was no way to shut it off a shut-down seemed certain. However, the hole was fortunately plugged with a sharpened stick of wood, but not until the boiler pressure had been seriously reduced and steam had been raised in the other boiler.

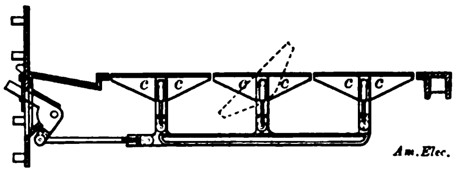


FIG. 3.—DUMPING GRATE.

Both boilers are provided with underfeed and underdraught mechanical stokers, built by the American Stoker Company. These are of the latest remodeled pattern. In place of the old style of grate a new pattern is used which has two sets of T-shaped tilting bars, there being three bars (*c*, *c*, *c*, Fig. 3) on each side of the stoker. These are hung on trunnions at the middle and can be tilted to a position at right angles to their normal position by means of a bar connecting each set together. The hopper and feeder worm are similar to previous patterns, but the casing and form are changed. The air comes into the lower part of the stoker, as shown in Fig. 5, at *A* and passes upward, emerging from the upper part of the stoker through two rows of holes, *B*, *B*, which allow the draught to blow through the bank of coal as it is fed inward and upward by the worm. The coal as it comes up from the worm, forced by the pressure of the continuous stream following it, spreads over the stoker proper and as it receives the extra supply of oxygen the combustible is thoroughly consumed and the refuse is pushed sidewise on to the dumping bars, *c*, *c*, *c*, just mentioned, which deliver it to the ash-pit. The exhaust steam from the stoker is turned into the ash-pit. As the details of the steam action are the same as in former patterns of this stoker it is unnecessary to burden this article with that description. The stoker blower and engine were made by the Sturtevant Company, the engine being a 5-in. x 5-in. vertical automatic. The air leaves the blower through a galvanized-iron duct which starts with a diameter of 18 ins. and enlarges to 28 ins. This duct is covered over by iron plates resting on brick walls at the level of the floor.

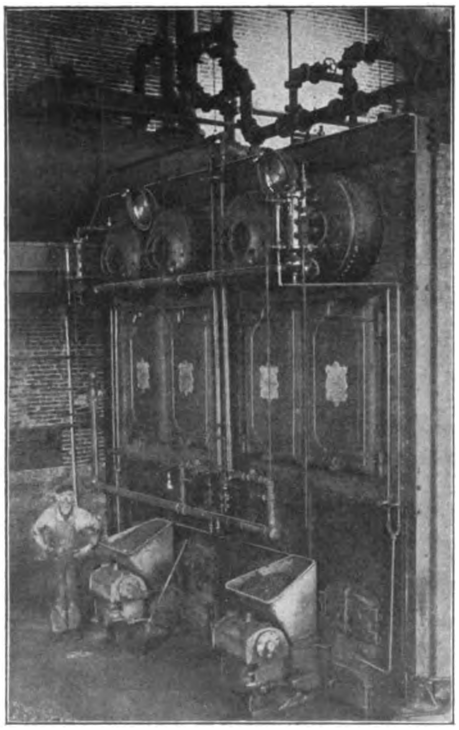


FIG. 4.—PARTIAL VIEW OF BOILERS.

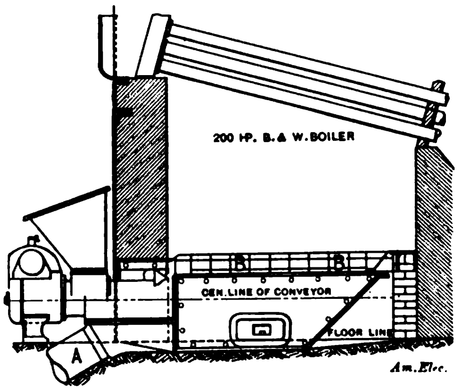


FIG. 5.—STOKER SETTING.

The chimney is a combination brick and steel structure, 94 ft. high. The lower 34 ft. is of brick with a 6-ft. diameter and 13-in. walls; the inside of this part is lined with fire brick. The steel portion is 60 ft. high and also 6 ft. in diameter; this part is built of No. 8 and No. 10 sheet steel, and rests on a heavy cast-iron plate on top of the brick stack.

The steam plant is equipped with both a purifier and a heater, of the Hoppes Manufacturing Company's make. The heater is fitted with one tier of trough-shaped pans, five pans being placed in a tier; each pan is 5 ft. long, and the heater has a total heating and lime-catching surface of 150 sq. ft. The purifier has three tiers of trough-shaped pans, six pans being placed in each tier; each pan is 6 ft. long, with a total heating and lime-catching surface of 546 sq. ft. The rated capacity of the heater and purifier is 300 horse-power each. Although this capacity is less than that of the total boiler rating, the return of the water of condensation makes up the deficiency when the plant has a load of over 300 horse-power. Two Stilwell-Bierce pumps, 10 ins. x 7 ins. x 4½ ins., located alongside the boilers, handle the boiler feed; they take the water from a well. The piping connections are described in another part of this article.

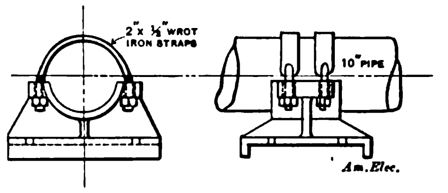


FIG. 6.—ANCHOR SADDLE.

The engines are of the well-known high-duty type, with double valves, built by the Buckeye Engine Company. Three have been installed so far; all three have cylinders of 14¼ ins. bore and 16 ins. stroke, and they are direct-connected to the dynamos. The usual Buckeye governor and auxiliary devices are used. Each engine is rated at 156 horse-power, with 120 lbs. initial steam pressure, running at a speed of 225 r.p.m. The engines are guaranteed to carry a maximum load of 220 horse-power in case of an emergency. The foundations for the three generating sets are of brick and Portland cement, so constructed that they are continuous and form one solid mass. The upper parts on which the engines and dynamos rest are made up of concrete artificial stone.

Fig. 8 shows the steam piping for the boilers and engines, and Fig. 9 the piping for the pumps and heater. All steam piping is of extra heavy wrought iron, with flange connections. This part of the work was installed by the M. H. Crane estate, Cincinnati, Ohio. The main steam pipes from the boilers are 8-in. and lead to a 10-in. header which extends along the east wall, through an opening in the partition wall, to the engine room, where 5-in. branches supply the engines individually. This header is supported on five hanger brackets of special design, one of which is shown by Fig. 7; it is anchored where it passes through the dividing wall by a saddle, Fig. 6, held by four ¾-in. rods embedded 30 ins. in the wall. A special 2-in. pipe also hung in the brackets serves as a "bleeder" for the water

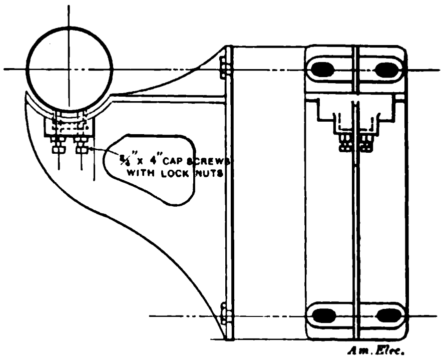


FIG. 7.—PIPE HANGER BRACKET.

of condensation forming in the pipe; this "bleeder" discharges through a trap valve into the sewer. Expansion in the header is taken care of by rollers in the brackets on which the pipe rests, the pipe being rigidly strapped to the iron saddle where it passes through the dividing wall. Each engine receives steam through a gate valve placed in the individual supply pipe where it leaves the header. The engine steam pipes have fire bends of 7-ft. radius and deliver steam through Cochrane sep-

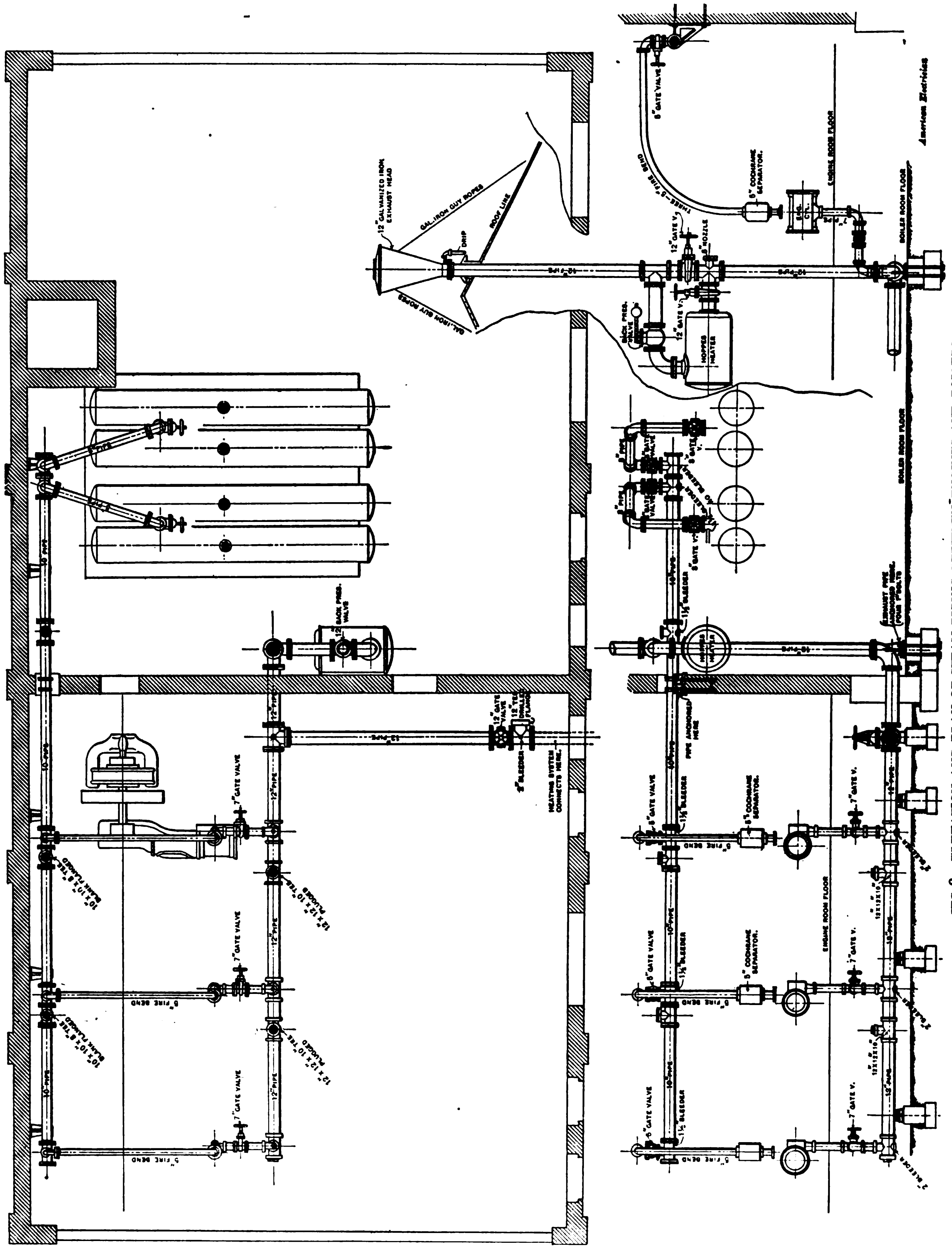
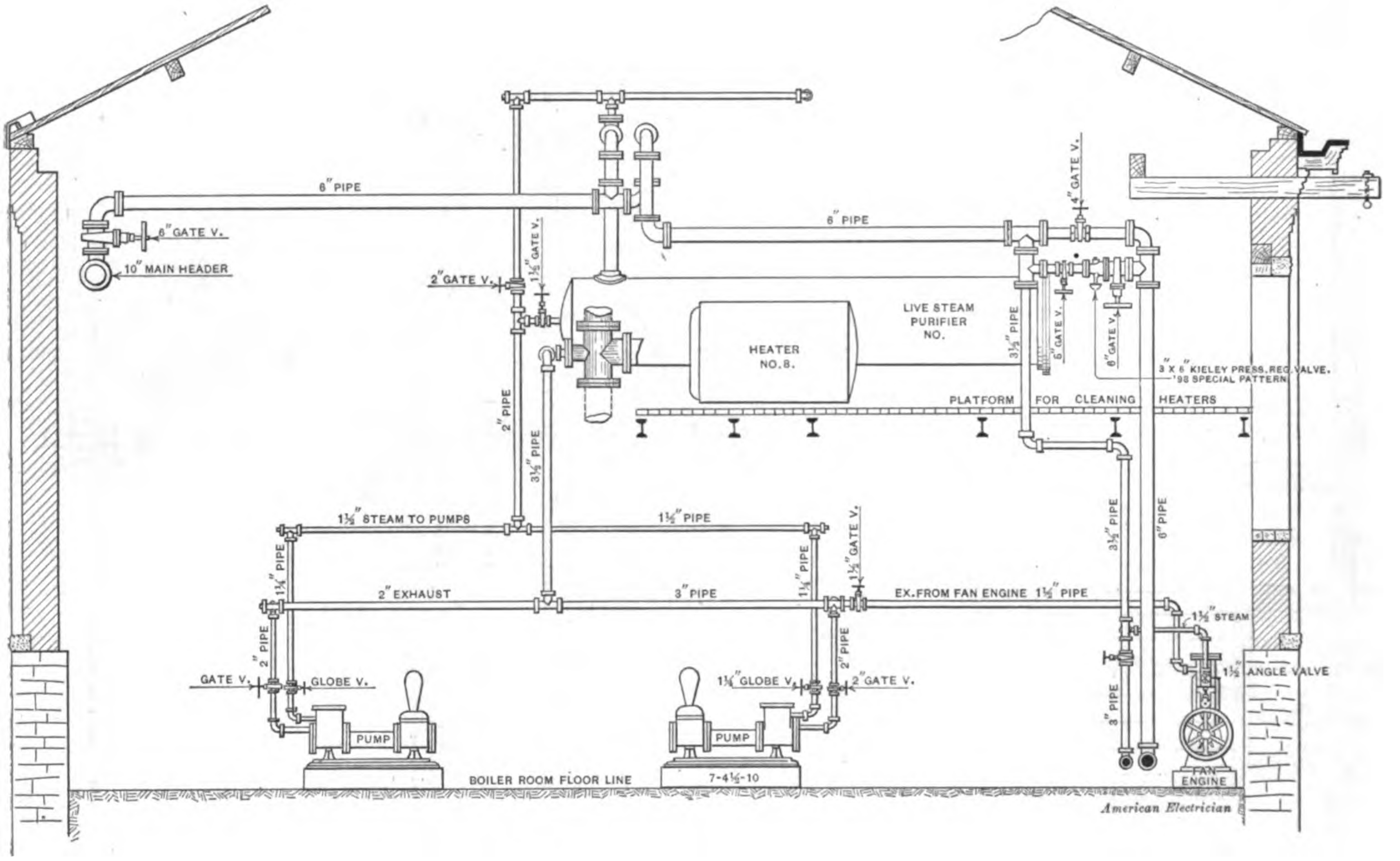
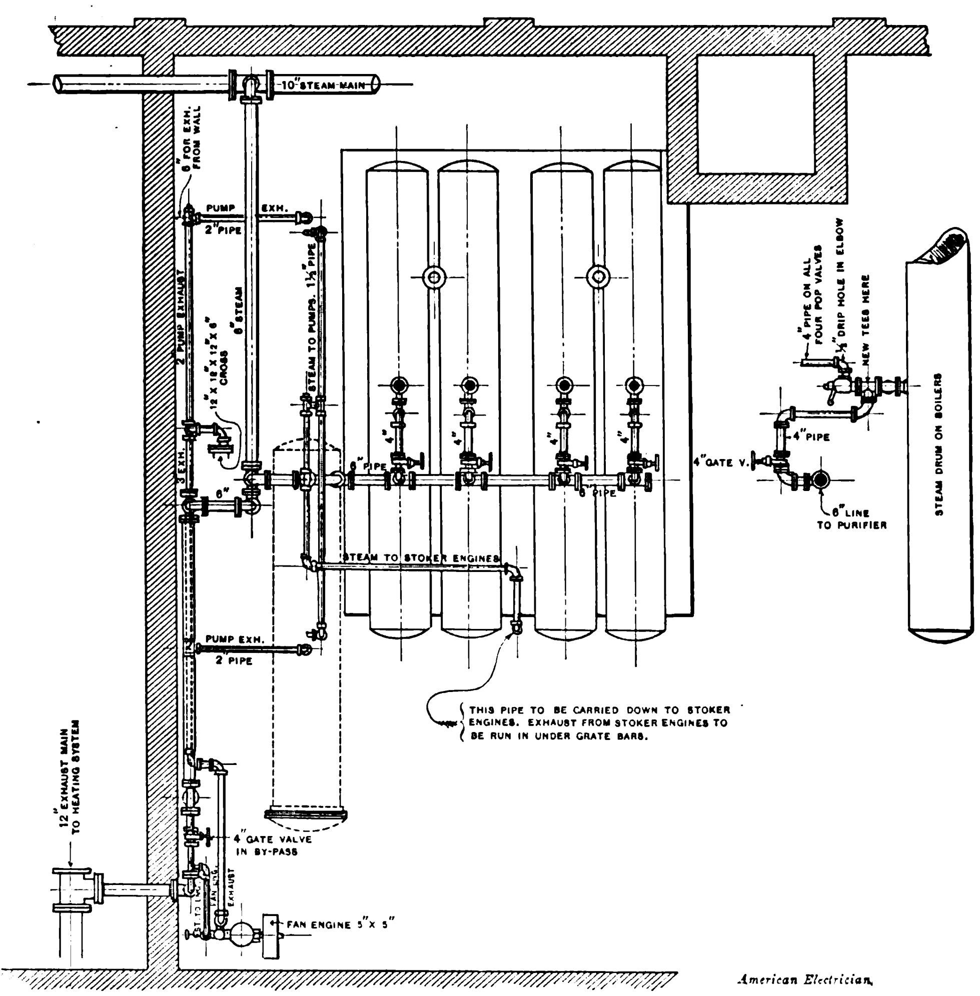


FIG. 8.—ELEVATION AND PLAN OF STEAM PIPING BETWEEN ENGINES AND BOILERS.



American Electrician

FIG. 9.—STEAM PIPING FOR PUMPS, HEATER AND PURIFIER.



American Electrician.

FIG. 10.—PLAN OF BOILER CONNECTIONS.

arators (built by Harrison Safety Boiler Works) placed just above the throttle valves. Detroit lubricators are used. The individual exhaust pipes discharge into a 12-in. header which has two outlets, one to the underground heating system and the other through the feed-water heater to the roof, where an exhaust head is provided, as shown in Fig. 8.

Besides the two 8-in. steam pipes from the boilers there is also another set of 4-in. pipes (see Fig. 10) which tap the pipe provided for the safety valves. Two rise from each boiler and unite in a 6-in. header which supplies the pumps, stoker engine and the underground system with live steam and also forms a by-pass to the main 10-in. steam header just as it enters the engine room. This part of the piping is shown in Fig. 10. The water supply piping, shown in Fig. 11, has connections so either pump can be made to supply a 60-bbl. steel tank on the roof, from which tank the water runs by gravity to the purifier and is then pumped into the boilers by the other pump. The city water is also available, although it is only used in case of the failure of the well. The boilers have blow-off connections through 3-in. pipes to a cistern in the boiler room. This cistern is provided with an overflow drain and a vent for the steam received by the discharge of the blower engine and the pumps.

There are three six-pole dynamos, each of 100-kw. capacity, direct-connected to the engines, as previously stated. These are General Electric machines. The brush

e.m.f. is 120 volts at no load and 125 volts at full load. The dynamos are over-compounded 10 per cent, but this is reduced by a German silver shunt to 3 per cent. The series field windings were designed to have as nearly as possible the same resistance, and tests showed a reasonable division of the load when all three were run in parallel. Below are the results of one of the tests made by the consulting engineer, Mr. Bert L. Baldwin. Loads of 410, 550, 533, 970 and 1170 amperes were shifted from one machine to the three. No. 1 dynamo took a larger portion of the load, which was due to its having been run longer and being consequently in better condition. It was also found later that No. 1 could be made to take less load by reducing its voltage below that of No. 2 and 3 before throwing on the load. The General Electric Company has since the time of the test sent another resistance shunt for the No. 1 dynamo.

DIVISION OF CURRENT BETWEEN DYNAMOS.

No. 1 Dynamo.	No. 2 Dynamo.	No. 3 Dynamo.
165	109	145
230	140	180
245	143	145
445	230	295
560	230	350

The switchboard has five panels, three for the dynamos, and two for the feeder

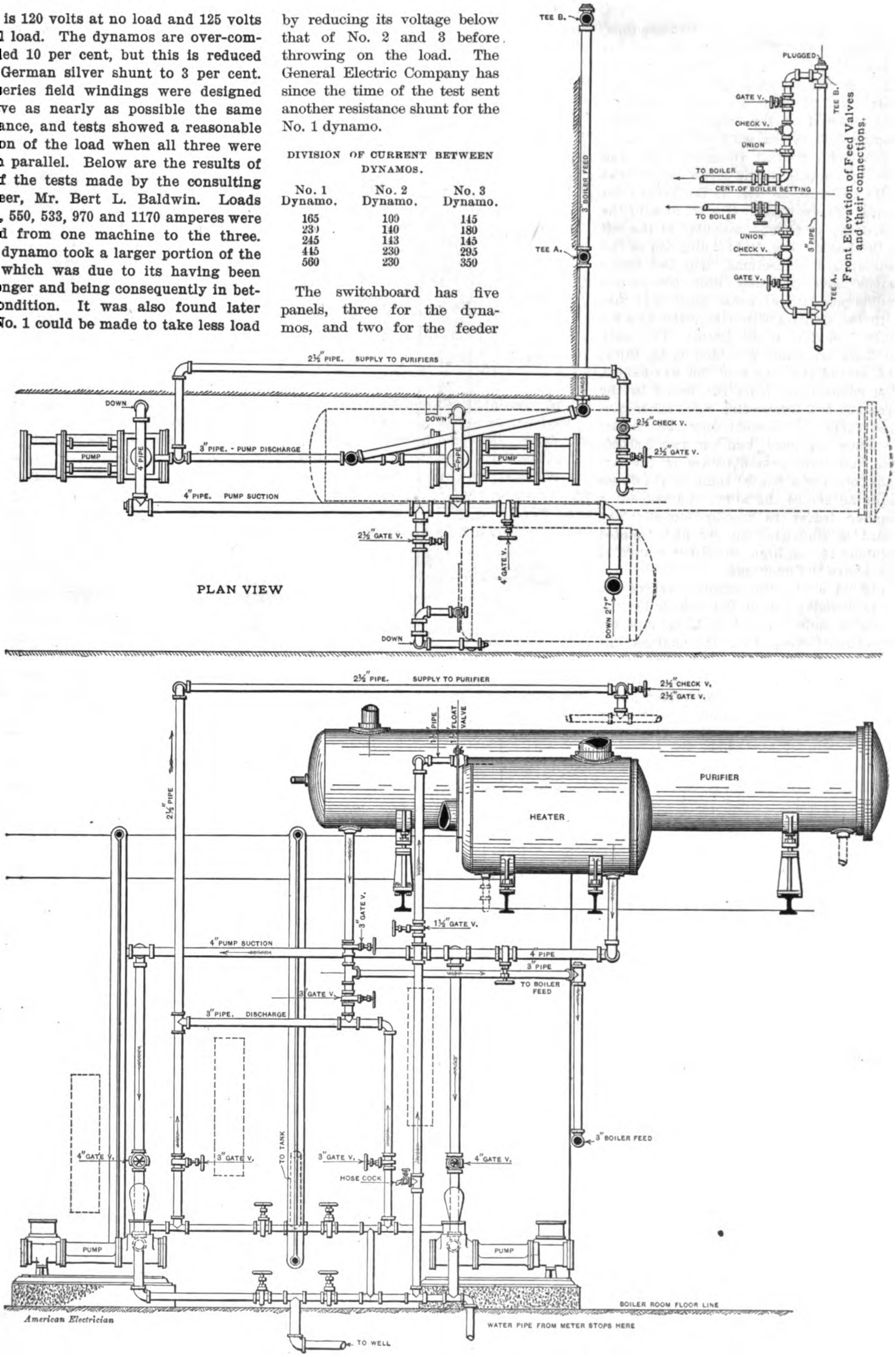


FIG. 11.—ELEVATION AND PLAN VIEWS OF WATER CONNECTIONS.

switches. Each panel is in two sections, the upper being 62 ins. by 24 ins. and the lower 16 ins. by 24 ins. Each generator panel carries a 1200-ampere Weston ammeter; a 1200-ampere circuit-breaker; a field rheostat on the back of the board; a shunt field switch, with discharge lamp; a four-point contact voltmeter plug, and three single-pole single-throw quick-break knife switches, as well as the usual pilot lamps. The voltmeter is a Weston, of the "swinging-arm" type, mounted at the left of the board. Fig. 13 is a diagram of the switchboard connections. The two feeder panels have on them nine 500-ampere double-pole single-throw knife switches with the General Electric spring clip for quick breaking of the circuit. The main bus-bars are 5 ins. wide and ¼ in. thick, and extend the length of the five panels. The connections from the board to the dynamos are 400,000-circ. mil rubber-covered cable. At present only four feeder switches are used, two for two 500,000-circ. mil lead-covered cables to the Arcade, one for a No. 00 cable to the Press Building across the alley, and one for a smaller feeder to nearby stores. The board is supported on six nickel-plated columns 12 ins. high, so that it stands 12 ins. above the floor line.

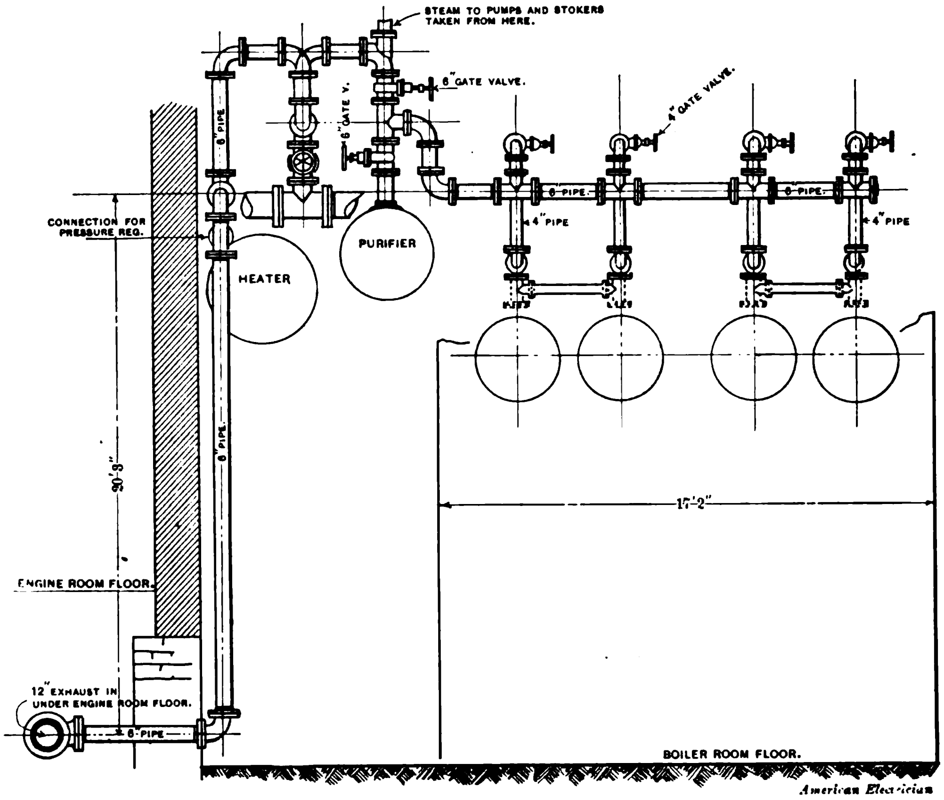


FIG. 12.—FRONT ELEVATION OF PURIFIER CONNECTIONS.

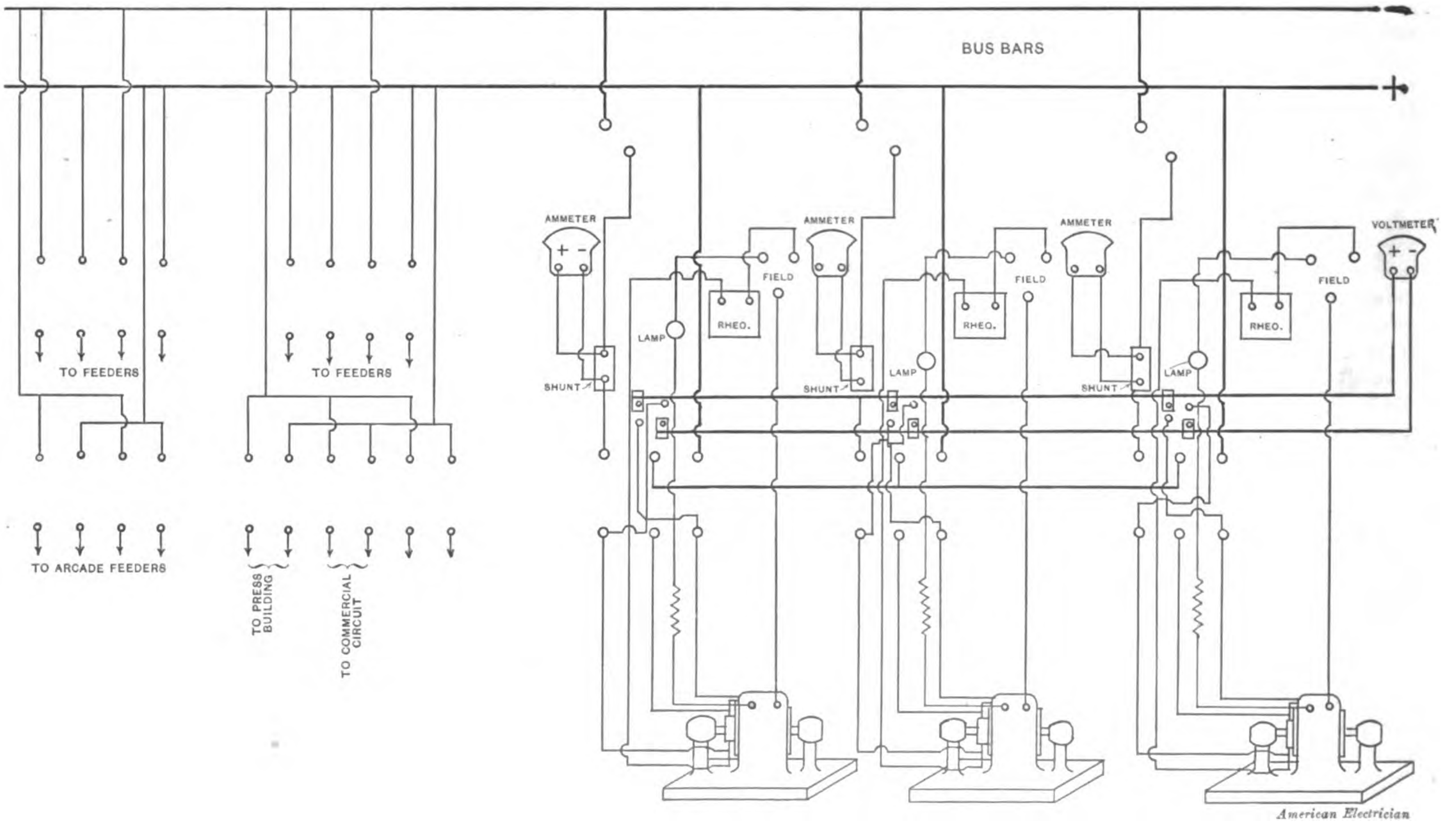


FIG. 13.—DIAGRAM OF SWITCHBOARD WIRING.

Fig. 14 shows the arrangement of the three steam pipes in the trench leading to the Arcade; there is a 12-in. pipe for the exhaust steam from the engines, one 3-in. pipe to convey high-pressure steam to the vacuum pump under the Arcade and supply other needs for higher pressure at the hotel, and another 3-in. pipe which is the return to bring back the water of condensation; the Paul system of steam heating is used in the Arcade Building. The principle of the Paul system is, briefly, the drawing of steam through the pipes by attaching a pump at the outer end of the system and thus creating a partial vacuum which is filled by the following steam, even at a low pressure such as that of exhaust steam. The return water of condensation is pumped into an iron tank of 60 barrels capacity placed on the roof, from which point it is again pumped into the boilers. The oil from the engine exhausts is removed by a trap. Each of the underground pipes is covered by patented double wooden coverings of octagon shape, having the two parts separated by tarred paper. The sections are 8 ft. long and each length had the outer covering removed for 6 ins. on one end and the inner cover removed on the other end, so the lengths can be driven together, making tight fits at the joints. The inner and outer parts of the pipe covering are made up of matched wooden boards bound together by wrappings of galvanized-iron wire, and it is coated with tar on the outside. The tarred exterior is rolled in sawdust to facilitate the handling of the covering.

It was the intention of the engineer to drain all of the condensed steam in the pipes in the direction of its flow, since the plant is on higher ground than the places to be heated. The steam pipes and the electric cable conduits were laid side by side in the same alley, taking up a width of 7 ft. As the alley is but 10 ft. wide the undertaking was a difficult one on account of the dirt to be handled and the nearness of the building foundations. No serious difficulty was encountered in excavating, however, until the crossings at Limestone street were reached. Here were first the telephone ducts which began close to the pavement and extended 40 ins. below it; under these was a water pipe, still lower a 12-in. tile sewer, and finally a foot lower another tile sewer 6 ins. in diameter. This compelled the pipes to be placed 5 ft. below the proposed grade, which brought the steam pipes, especially the exhaust pipe, which is the under one, dangerously near the level of a creek only 50 ft. away. At a point 220 ft. from the end of the line it was found necessary to raise the pipes 26 ins. and insert an elbow. A "bleeder" pipe and water trap were placed here to drain the exhaust steam pipe. This drain pipe was carried under the mains to the Arcade Building where it discharges into the sewer.

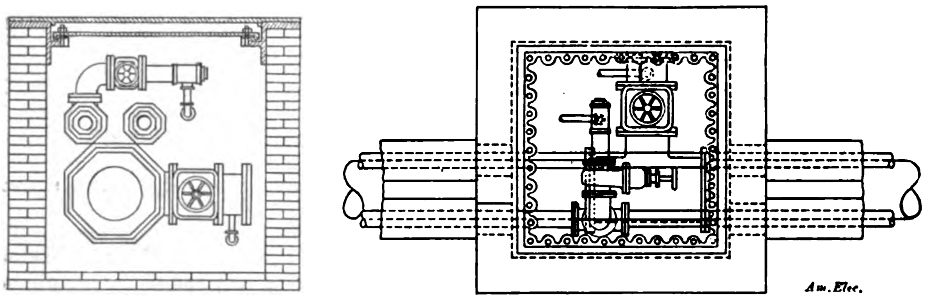


FIG. 14.—DETAILS OF STEAM PIPE MANHOLE.

Manholes were placed at four points along the line, one at the first turn in the alley at the rear of the plant, where anchor piers were also provided; another 150 ft. further along, at which point a brass expansion joint for each pipe was placed, the third at a point 200 ft. further along the line, also provided with expansion joints, and the fourth at the end of the line where a set of tees and branch line valves are placed. Anchor piers are also placed midway between the expansion joints and at the end of the line. These consist of brick and cement and have the pipes embedded in them. The latter have collars bolted on to make them hold in the piers. Fig. 14 gives details of a manhole. The expansion joints have heavy chains and collars attached to prevent them from pulling apart when the pipes contract.

The conduit for the electric cables is the well-known Camp tile. It is laid in rows with ⅛ in. of Portland cement between each row to bind the tiles, and a wall 6 ins. thick, consisting of one part Louisville cement, two parts sand and five parts screened gravel, completely envelops the tiles. The line starts with 32 ducts at the power house, a manhole being placed at this point, so that it opens one side into the building. At the corner of the cross alleys at the rear of the plant is another manhole. From this the main line of 20 ducts runs west to the Arcade. There are 12 "blind" ducts in the east wall and 16 "blind" ducts in the north wall of this manhole. The 20 ducts continue to the third manhole at Limestone street, where 16 blind ducts are placed on the north and 12 on the south side. At the Arcade manhole, or No. 4, there are 8 ducts carried into the basement of the building, while the balance stop at this manhole. At present but 4 ducts are used for the lead-covered cables supplying current to the lights and motors used at the Arcade. Fig. 15 shows the arrangement of the ducts and the details of a conduit manhole.

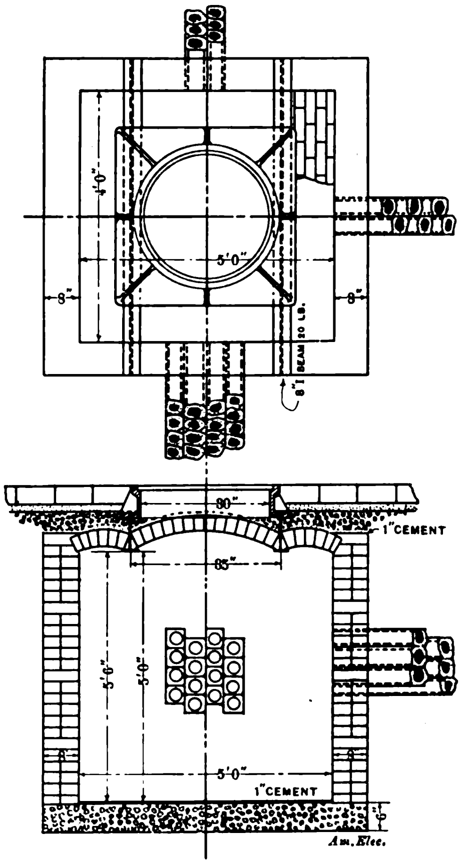


FIG. 15.—CONDUIT MANHOLE.

The laying of the tile itself was rapid, the greatest difficulty being the excavation and preparation of the trench. This was given an average depth of 4½ ft., the bottom being carefully smoothed. Then a layer of concrete 6 ins. thick was put on the bottom of the trench; this was allowed to harden for 12 hours. A thin layer of Portland cement was put over the surface of the concrete, on which the tile was laid. The usual Camp conduit mandrels were inserted and pulled through the tile, smoothing out the surplus cement at the joints. A layer of tile was run for a hundred or more feet and then another layer put on top of this, and so on, until the number of layers desired were in place, each layer having ⅛ in. of Portland cement to bind it to its neighbor. The tiles were not at once covered on top and along the sides, but allowed to stand until the thin layers of cement had sufficiently hardened. The concrete side walls and top were then filled in and allowed to become hard before filling in the trench. This was done in order to prevent the tiles from being displaced by careless workmen when the earth was tamped on top of them. It was found necessary to provide 1½-in. pipe vents for each manhole owing to leaky natural gas pipes.

After the ducts were ready to receive the cable a "pilot" wire was drawn into each of them from one manhole to the next. From the first manhole at the power house to the next is but 70 ft., so it was an easy matter to push a No. 8 galvanized-iron wire through. As the second manhole from the plant marks a right-angle turn, the cable was started here and the pilot wires pulled from it to the next manhole, a distance of 265 ft., by means of jointed rods made up in 4-ft. lengths. As each joint was pushed into the duct another one was screwed on and the entire length finally pushed to the next manhole. Each section of a jointed rod consisted of a 4-ft. oak piece 1 in. square. The sections were fastened together with the old-fashioned pump rod screws used in the oil fields. This home-made contrivance cost five cents a foot completed and did the work of a high-priced jointed rod. The pilot wires having been pulled through the ducts, served to pull through a stout rope to which the cables were spliced. The latter were pulled through the ducts by means of a hand winch. Each of the 500,000-circ. mil Paranite cables was pulled through from the power house to the Arcade basement without a splice. At the Arcade end the cables are connected to a marble switchboard designed for this purpose.

The exhaust steam system causes a back pressure of from 3 to 5 lbs. during severe cold weather, but this runs down to 2 lbs. at the time of milder winter weather. The plant is owned by Mr. E. S. Kelly, for whom it was designed by the well-known engineering firm of Bert L. Baldwin & Company, of Cincinnati, Ohio. The plant is in operation all day and all night, and it is the intention to keep it running continuously, never shutting it down entirely.

POLE SETTING ON THE NEW ORLEANS DRAINAGE COMMISSION LINES.

The level of the city of New Orleans is so low with reference to surrounding bodies of water that most of the drainage has to be done by means of centrifugal pumps, which deliver the water into Lake Ponchartrain. Originally the work was done by scattered steam plants, but recently electrically-driven pumps have been substituted. These are located at different pumping stations and are supplied with current from a large central generating station which has been established for this purpose.

The pole lines run through low ground and swamps in many cases, and the New Orleans soil and climate tend to rot timber very rapidly. The plan of pole setting on a large part of the transmission lines was to put a box of slightly larger dimensions than the pole in a concrete setting, as shown in Figs. 1 and 2, herewith. Then the pole was slipped into this box and clean, sharp sand poured in around it. A sufficient space was left between the pole and box so that a narrow scoop can be put in to take out the sand without disturbing the concrete setting when it becomes necessary to put a new pole in the place of the old one. Square poles are used on all the work.

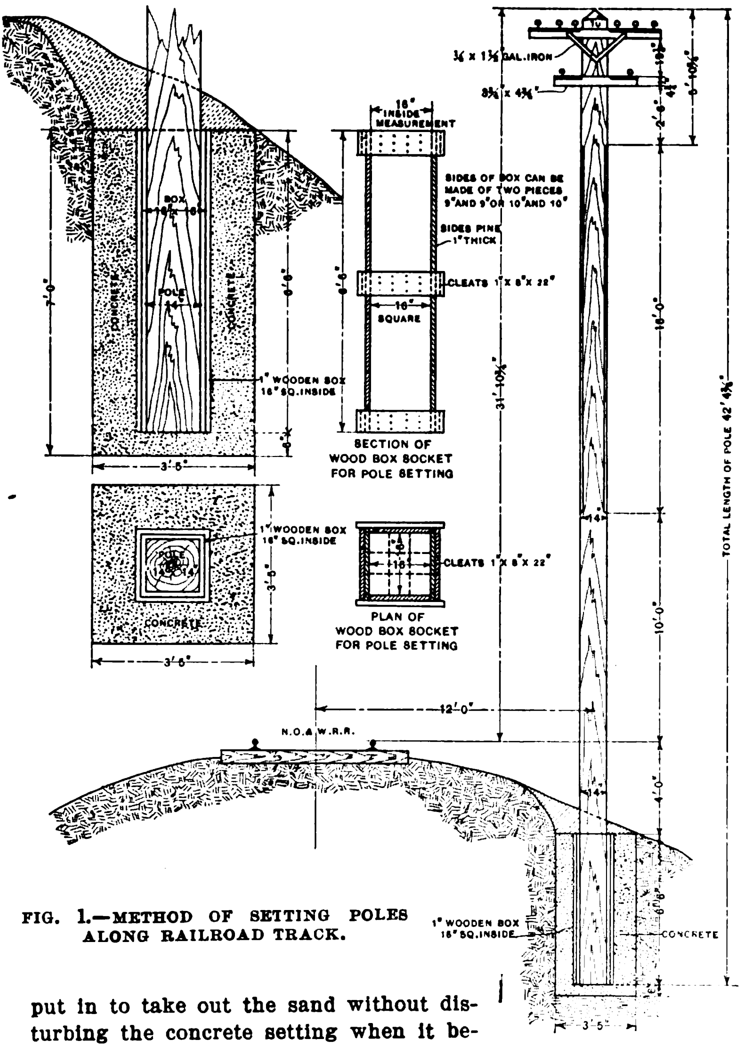

¼" x 1½" GAL. IRON
3⅝" x 4⅝"
16" INSIDE MEASUREMENT
SIDES OF BOX CAN BE MADE OF TWO PIECES 8" AND 9" OR 10" AND 10"
SIDES PINE 1" THICK
CLEATS 1" x 8" x 22"
16" SQUARE
SECTION OF WOOD BOX SOCKET FOR POLE SETTING
1" WOODEN BOX 16" SQ. INSIDE
PLAN OF WOOD BOX SOCKET FOR POLE SETTING
BOX
POLE
CONCRETE
7'-0"
3'-5"
16'-0"
10'-0"
31'-10½"
TOTAL LENGTH OF POLE 42'-4½"
12'-0"
N.O.& W.R.R.
4'-0"
14"

FIG. 1.—METHOD OF SETTING POLES ALONG RAILROAD TRACK.

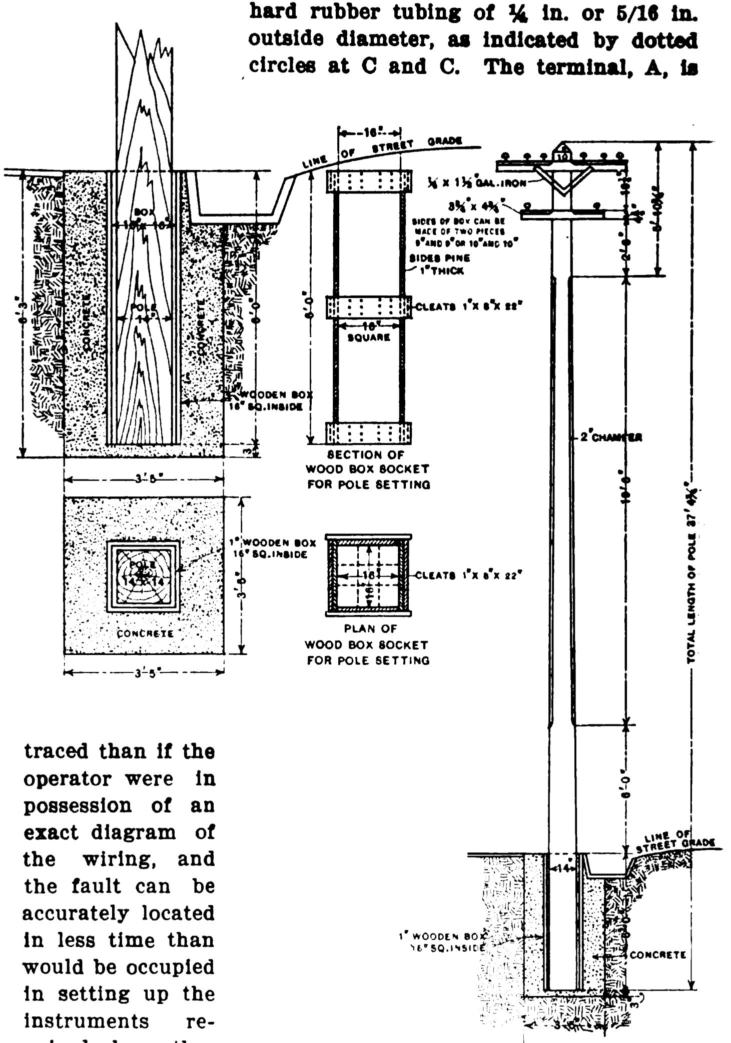

LINE OF STREET GRADE
¼" x 1½" GAL. IRON
3⅝" x 4⅝"
SIDES OF BOX CAN BE MADE OF TWO PIECES 8" AND 9" OR 10" AND 10"
SIDES PINE 1" THICK
CLEATS 1" x 8" x 22"
16" SQUARE
SECTION OF WOOD BOX SOCKET FOR POLE SETTING
1" WOODEN BOX 16" SQ. INSIDE
PLAN OF WOOD BOX SOCKET FOR POLE SETTING
BOX
POLE
CONCRETE
3'-5"
2" CHAMFER
TOTAL LENGTH OF POLE 37'-4½"
14"

FIG. 2.—METHOD OF SETTING POLES ALONG GUTTER.

Fig. 1 shows the arrangement for a line of poles set along a railroad track, and Fig. 2 shows the arrangement for poles set along the gutter on Broad Street. In very soft ground it was necessary to fasten the poles to piles driven 26 ft. below the surface of the ground. The details of this construction are shown in Fig. 3. For the details of the pole-line construction we are indebted to Mr. Ben Willard, New England agent of the General Electric Company, which was the contractor for the electrical equipment of the drainage work.

* * *

A SIMPLE METHOD OF LOCATING A SHORT CIRCUIT BETWEEN ELECTRICAL CONDUCTORS.

BY ARTHUR R. ROE.

When a short-circuit occurs in concealed electric light, annunciator or electric gas-lighting conductors, it is often very difficult, with the aid of the most delicate instruments obtainable, to exactly locate the fault; and in the majority of cases absolutely impossible unless an accurate plan of the system of wiring showing the length and location of every wire is available.

By the method under consideration, concealed conductors can be more accurately traced than if the operator were in possession of an exact diagram of the wiring, and the fault can be accurately located in less time than would be occupied in setting up the instruments required by other methods. This method is based upon the well-known law of induction, that a current started and stopped in a conductor induces inverse currents in neighboring conductors.

All the apparatus required for the test are an exploring coil in electrical connection with a telephone receiver, and a battery of from 3 to 8 cells, connected in parallel through an interrupter to the faulty circuit, as shown in Fig. 1, in which J is the exploring coil and T the telephone receiver.

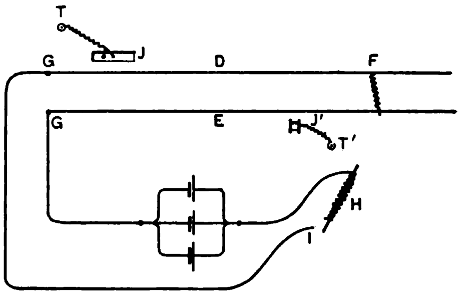


FIG. 1.—CONNECTIONS FOR LOCATING SHORT CIRCUIT.

The exploring coil, Fig. 2, should be wound with No. 36 or 40 B. & S. gauge silk-covered copper wire, on an oblong brass frame, insulated before being wound, 3 ins. long and 1 in. high, with a ½-in. space for the winding; the central core being formed of two 3/32-in. brass pins C and C, run through short lengths of hard rubber tubing of ¼ in. or 5/16 in. outside diameter, as indicated by dotted circles at C and C. The terminal, A, is connected directly to the frame, as is also the inside end of the coil; this terminal should be provided with two nuts and two washers, as it forms also a convenient means of attaching the coil to a pole, to the upper end of which a strip of soft copper with a hole drilled in its upper end to fit the post, A, is soldered to a thimble, L (Fig. 3), the latter being fitted to the end of the pole. By using a strip of soft copper the coil may be placed in any position in relation to the pole. The pole should be sufficiently long to enable the operator to run the coil along the ceiling of any room he may desire to explore; it is convenient to have the pole divided into four or five lengths, as is a fish pole, for ease of transportation, and also for adjustment to ceilings of different heights, as well as to reach into partitions, etc.

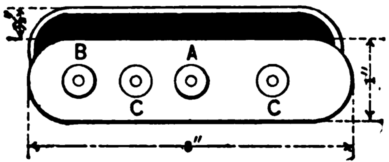


FIG. 2.—EXPLORING COIL.

Terminal B must be well insulated from the frame, as it forms the other terminal of the coil. Terminals A and B should be connected by flexible conductors to a double-head telephone receiver. The material of which the coil frame is made is, of course, optional; however, the brass frame is cheaper to make, and more durable than one of any other material.

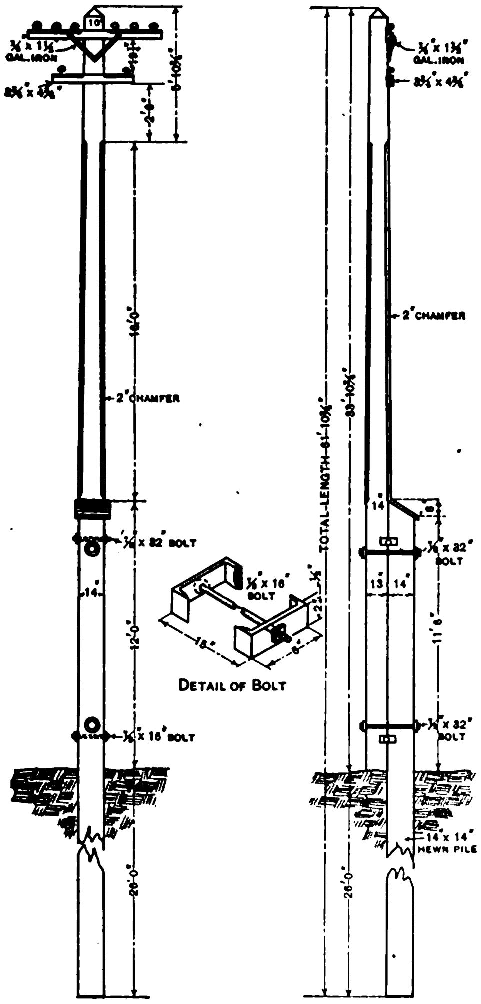


FIG. 3.—METHOD OF SETTING POLES IN SOFT GROUND.

In Fig. 1 the battery is shown connected in parallel with the faulty wires, D and E, at G and G, through a manually-operated interrupter, H, consisting of a coarse file, and a wire, I, which is rubbed in long even strokes over the surface of the file by an assistant. A slowly vibrating electrical interrupter of low resistance may be employed, but the file gives better results in the hands of an intelligent assistant, as for instance, when the battery shows signs of becoming weak, judging by the spark, a predetermined signal can be conveyed to the operator to rest for a certain period of time to allow the insertion of another set of cells, or for a sufficient period of time for the original set to recuperate.

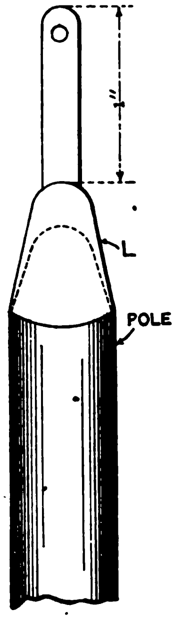


FIG. 3.

Upon the interrupter being set in motion, when the exploring coil, J, is held with its longitudinal axis parallel with either D or E, a sound will be heard in the telephone receiver, T, until the coil is brought over the point, F; if the short-circuit be of low resistance no sound will be heard in the telephone receiver when the coil is carried beyond point F; if the connection has some resistance, then when the coil passes the point, F, a noticeable diminution in the volume of sound emitted will be noticed, so that in either case the point, F, where the short-circuit exists, may be exactly located. When the coil is held with its longitudinal axis at right angles to the wires, as at J, no sound will be heard in the telephone receiver. By noting these facts, concealed wires may be easily and accurately traced and short-circuits accurately located.

With a battery of from three to six cells connected in parallel to the faulty wires the sound is quite audible in the telephone receiver when the conductors are concealed in ordinary lath and plaster walls, and are not more than 4 ins. from the outer surface of the walls; should the distance be greater, two to four additional cells may be necessary, depending largely upon the sensitiveness of the operator's ear.

The method of procedure is as follows: The interrupter, either hand or electrical, is set to work and the operator, with his exploring coil connected, as in Fig. 1, to the double-head receiver, runs the exploring coil along the walls, ceiling or floor until the receiver emits the characteristic sound; he then follows in a line directly through the longitudinal axis of the coil, or in a direction following which the receiver continues to emit sound, until a point is reached at which the receiver becomes silent, or at which there is a marked decrease in the volume of sound emitted; at this point the short-circuit will be found to exist.

The method of procedure is the same in testing for short-circuits in annunciator and electric gas-lighting circuits, except that in testing the latter the faulty circuit should be disconnected from any instrument to which it may be connected, and this free end connected to one side of the battery, through the interrupter, and the other side of the battery connected to a gas pipe.

The tests can be made with a single hand or head telephone receiver, but, for obvious reasons, the double-head receiver is preferable.

Before attempting a test the operator should have an assistant run some bare copper wires, with several "taps," along the under side of a bench or on the inside of a closet door, and cause him to make a short-circuit on one of the taps. The operator can then experiment with these circuits, and in a short time he will find it very easy to trace the wires and locate any short-circuits that may exist, and at the same time learn the significance of the different sounds emitted by the telephone receiver.

WINDINGS FOR ELECTROMAGNETS AND SOLENOIDS.

The first essential in the determination of the winding for an electro-magnet proper or one of the solenoid form is the exciting force of the coil in ampere-turns. This factor is preferably determined by experiment, the method being extremely simple and consisting of winding on the core or bobbin a temporary coil, preferably of much larger wire than will probably be used in the actual coil, making the length of the temporary coil about what the length of the permanent coil will be. The depth of the coil is immaterial within reasonable limits; it will be found most convenient to wind exactly 100 turns of wire in the temporary coil, so that the ampere-turns will be 100 times the current flowing through the coil. Then pass current through the temporary winding from any convenient source, regulating its strength by means of a resistance coil until the magnet does the work for which it is being built. The ampere-turns required in the permanent coil will be 100 times the current which flows in the temporary coil when the magnet does the work required of it.

If facilities are not at hand for making the preliminary trial, the ampere-turns may be found approximately by means of the tables given in last month's article, provided the magnet is a purely tractive one—that is, intended to exert its force through the medium of an armature in actual contact with its pole-faces—or of either of the "stopped" solenoid types represented by Figs. 5 and 6. The ampere-turns necessary to drive magnetic lines through any path are directly proportional to the length of path and to the density in lines per square inch of cross-sectional area offered by the path; also inversely proportional to the permeability of the path. It is not necessary, however, to burden one's mind with formulas which take into account permeability; the tables

TABLE III.—SHOWING THE MEAN LENGTH PER TURN OF MAGNET WIRE REQUIRED FOR DIFFERENT AMPERE-TURNS, PER VOLT OF E.M.F. AT THE COIL TERMINALS. TEMPERATURE, 140° FAHR.

Ampere Turns.	Wire Sizes; B. & S. Gauge.																										
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1000	41.84	33.18	26.31	20.86	16.55	13.12	10.400	8.254	6.546	5.191	4.116	3.264	2.589	2.053	1.628	1.291	1.024	.812	.644	.5106	.4050	.3212	.2547	.2020	.1602	.1270	.1007
1100	38.04	30.16	23.92	18.97	15.04	11.93	9.461	7.504	5.950	4.719	3.742	2,968	2.353	1.866	1.480	1.173	.931	.738	.585	.4642	.3681	.2920	.2315	.1836	.1456	.1154	.09159
1200	34.87	27.65	21.93	17.39	13.79	10.93	8.672	6.878	5.455	4.326	3.430	2.720	2.157	1.711	1.357	1.076	.853	.676	.536	.4255	.3375	.2676	.2122	.1683	.1335	.1058	.08395
1300	32.19	25.52	20.24	16.05	12.73	10.09	8.006	6.350	5.035	3.993	3.166	2.511	1.991	1.579	1.252	.993	.787	.624	.495	.3928	.3115	.2470	.1959	.1553	.1232	.09772	.07750
1400	29.88	23.70	18.79	14.90	11.82	9.376	7.434	5.896	4.675	3.708	2.940	2.331	1.849	1.466	1.163	.922	.731	.580	.460	.3647	.2892	.2294	.1819	.1442	.1144	.09078	.07196
1500	27.90	22.12	17.54	13.91	11.03	8.750	6.938	5.503	4.364	3.460	2.744	2.176	1.726	1.368	1.085	.860	.682	.541	.429	.3404	.2700	.2141	.1698	.1346	.1068	.08468	.06716
1600	26.15	20.74	16.44	13.04	10.34	8.204	6.504	5.159	4.091	3.244	2.573	2.040	1.618	1.283	1.017	.807	.640	.507	.402	.3191	.2531	.2007	.1592	.1262	.1001	.07939	.06296
1700	24.61	19.52	15.48	12.27	9.736	7.722	6.122	4.855	3.850	3.053	2.421	1.920	1.523	1.207	.957	.759	.602	.477	.378	.3004	.2382	.1889	.1498	.1188	.09422	.07472	.05926
1800	23.25	18.43	14.62	11.59	9.195	7.293	5.782	4.586	3.636	2.844	2.287	1.814	1.438	1.140	.904	.717	.568	.451	.357	.2837	.2250	.1784	.1415	.1122	.08900	.07057	.05597
1900	22.02	17.46	13.85	10.97	8.711	6.909	5.478	4.344	3.445	2.732	2.166	1.718	1.362	1.080	.857	.679	.538	.427	.339	.2687	.2131	.1690	.13405	.1063	.08431	.06686	.05302
2000	20.92	16.59	13.15	10.43	8.275	6.563	5.204	4.127	3.273	2.595	2.058	1.632	1.294	1.026	.814	.645	.512	.406	.322	.2553	.2025	.1606	.12735	.1010	.08010	.06352	.05037
2100	19.92	15.80	12.53	9.936	7.881	6.250	4.955	3.930	3.117	2.472	1.960	1.554	1.233	.977	.775	.614	.487	.386	.3066	.2431	.1928	.1529	.12128	.09618	.07628	.06049	.04797
2200	19.02	15.08	11.96	9.485	7.523	5.966	4.730	3.752	2.975	2.359	1.871	1.483	1.176	.933	.740	.586	.465	.369	.2927	.2321	.1840	.1460	.11576	.09182	.07281	.05774	.04579
2300	18.19	14.42	11.44	9.073	7.196	5.707	4.525	3.589	2.846	2.257	1.790	1.419	1.125	.892	.708	.561	.445	.353	.2800	.2220	.1760	.1396	.11073	.08782	.06965	.05523	.04380
2400	17.43	13.82	10.96	8.695	6.896	5.470	4.336	3.439	2.727	2.163	1.715	1.360	1.078	.855	.678	.538	.426	.338	.2683	.2127	.1687	.1338	.10612	.08416	.06674	.05292	.04197
2500	16.73	13.27	10.52	8.347	6.620	5.250	4.163	3.301	2.618	2.076	1.646	1.305	1.035	.821	.651	.516	.409	.3248	.2576	.2042	.1620	.1284	.10188	.08080	.06408	.05081	.04029
2600	16.09	12.76	10.12	8.026	6.366	5.048	4.003	3.175	2.517	1.996	1.583	1.255	.995	.789	.626	.496	.393	.3123	.2477	.1964	.1557	.1235	.09796	.07768	.06161	.04886	.03875
2700	15.50	12.29	9.746	7.728	6.130	4.861	3.854	3.057	2.424	1.922	1.524	1.209	.958	.760	.603	.478	.379	.3007	.2385	.1891	.1500	.1189	.09432	.07480	.05932	.04704	.03731
2800	14.94	11.85	9.398	7.452	5.911	4.688	3.717	2.948	2.337	1.854	1.470	1.166	.924	.733	.581	.461	.365	.2900	.2300	.1823	.1446	.1147	.09096	.07214	.05721	.04537	.03598
2900	14.43	11.44	9.074	7.196	5.707	4.526	3.588	2.846	2.257	1.790	1.419	1.125	.892	.708	.561	.445	.353	.2800	.2220	.1761	.1396	.1107	.08782	.06965	.05524	.04380	.03474
3000	13.95	11.06	8.771	6.956	5.516	4.375	3.469	2.751	2.182	1.730	1.372	1.088	.863	.684	.542	.430	.341	.2706	.2146	.1702	.1350	.1070	.08490	.06732	.05340	.04234	.03358
3100	13.50	10.70	8.488	6.732	5.339	4.234	3.357	2.662	2.111	1.674	1.328	1.053	.835	.662	.525	.416	.330	.2619	.2077	.1647	.1306	.1036	.08216	.06516	.05168	.04097	.03250
3200	13.07	10.37	8.224	6.521	5.172	4.102	3.252	2.579	2.045	1.622	1.286	1.020	.809	.641	.508	.403	.320,	.2537	.2012	.1595	.1265	.1003	.07959	.06312	.05006	.03970	.03148
3300	12.68	10.05	7.974	6.323	5.015	3.977	3.153	2.501	1.983	1.573	1.247	.989	.784	.622	.493	.391	.3102	.2460	.1951	.1547	.1227	.0973	.07718	.06120	.04854	.03849	.03052
3400	12.30	9.760	7.740	6.138	4.868	3.861	3.061	2.427	1.925	1.526	1.210	.960	.761	.603	.478	.379	.3011	.2388	.1894	.1502	.1191	.0944	.07490	.05940	.04711	.03736	.02963
3500	11.95	9.480	7.518	5.962	4.728	3.750	2.973	2.358	1.870	1.483	1.176	.932	.739	.586	.465	.368	.2925	.2320	.1840	.1459	.1157	.0917	.07276	.05771	.04577	.03629	.02878
3600	11.62	9.218	7.310	5.796	4.597	3.646	2.891	2.293	1.818	1.442	1.143	.906	.719	.570	.452	.358	.2844	.2255	.1789	.1418	.1125	.0892	.07075	.05610	.04450	.03528	.02798
3700	11.31	8.968	7.112	5.640	4.473	3.547	2.812	2.231	1.769	1.403	1.112	.882	.699	.554	.440	.349	.2767	.2194	.1740	.1380	.1094	.0868	.06884	.05460	.04330	.03433	.02722
3800	11.01	8.732	6.925	5.492	4.355	3.454	2.738	2.172	1.722	1.366	1.083	.859	.681	.540	.428	.339	.2694	.2137	.1694	.1343	.1065	.0845	.06702	.05315	.04215	.03343	.02651
3900	10.73	8.508	6.748	5.350	4.244	3.366	2.668	2.116	1.678	1.331	1.055	.837	.663	.526	.417	.331	.2625	.2082	.1651	.1309	.1038	.0823	.06530	.05180	.04107	.03257	.02583
4000	10.46	8.296	6.579	5.217	4.137	3.281	2.602	2.063	1.636	1.297	1.029	.816	.647	.518	.407	.322	.2560	.2030	.1610	.1276	.1012	.0803	.06367	.05050	.04005	.03175	.02518
4100	10.20	8.094	6.418	5.090	4.037	3.201	2.538	2.013	1.596	1.266	1.004	.796	.631	.500	.397	.314	.2497	.1980	.1570	.1245	.0987	.0783	.06212	.04927	.03907	.03098	.02457
4200	9.962	7.90	6.265	4.968	3.940	3.125	2.473	1.965	1.558	1.236	.980	.777	.616	.488	.387	.307	.2437	.1933	.1533	.1215	.0964	.0764	.06064	.04809	.03814	.03024	.02398
4300	9.732	7.717	6.120	4.853	3.849	3.052	2.420	1.919	1.522	1.207	.957	.759	.602	.477	.378	.3002	.2381	.1888	.1497	.1187	.0941	.0747	.05923	.04697	.03725	.02954	.02342
4400	9.510	7.542	5.980	4.742	3.761	2.983	2.365	1.876	1.487	1.179	.935	.742	.588	.466	.370	.2934	.2327	.1845	.1463	.1160	.0920	.0730	.05788	.04591	.03641	.02887	.02289
4500	9.300	7.374	5.848	4.637	3.678	2.917	2.312	1.834	1.454	1.153	.914	.725	.575	.456	.361	.2869	.2275	.1804	.1431	.1134	.0900	.0713	.05660	.04489	.03560	.02823	.02238
4600	9.097	7.214	5.720	4.536	3.598	2.853	2.262	1.794	1.423	1.128	.895	.709	.562	.446	.354	.2807	.2226	.1765	.1400	.1110	.0880	.0698	.05537	.04391	.03482	.02761	.02190
4700	8.903	7.060	5.598	4.440	3.521	2.792	2.214	1.756	1.392	1.104	.875	.694	.550	.436	.346	.2747	.2178	.1727	.1370	.1086	.0861	.0683	.05419	.04298	.03408	.02702	.02143
4800	8.718	6.913	5.482	4.347	3.448	2.734	2.168	1.719	1.363	1.081	.857	.680	.539	.427	.339	.2690	.2133	.1691	.1341	.1064	.0843	.0669	.05306	.04208	.03337	.02646	.02099
4900	8.540	6.774	5.370	4.258	3.377	2.679	2.124	1.684	1.336	1.059	.840	.666	.528	.419	.332	.2635	.2089	.1657	.1314	.1042	.0826	.0655	.05198	.04122	.03269	.02592	.02056
5000	8.369	6.636	5.263	4.173	3.310	2.625	2.081	1.651	1.309	1.038	.823	.653	.517	.410	.325	.2582	.2048	.1624	.1288	.1021	.0810	.0642	.05094	.04040	.03204	.02540	.02015
5200	8.047	6.382	5.060	4.013	3.183	2.524	2.001	1.587	1.258	.998	.791	.627	.497	.394	.313	.2483	.1969	.1561	.1238	.0982	.0778	.0617	.04898	.03884	.03080	.02443	.01937
5400	7.750	6.145	4.873	3.864	3.065	2.431	1.927	1.528	1.212	.961	.762	.604	.479	.380	.301	.2391	.1896	.1503	.1192	.0945	.0750	.0594	.04716	.03740	.02966	.02352	.01865
5600	7.472	5.926	4.699	3.726	2.955	2.344	1.858	1.474	1.168	.927	.735	.583	.462	.366	.2907	.2305	.1828	.1450	.1150	.0912	.0723	.0573	.04548	.03607	.02860	.02268	.01799
5800	7.215	5.721	4.537	3.598	2.853	2.263	1.794	1.423	1.128	.896	.709	.562	.446	.354	.2807	.2226	.1765	.1400	.1110	.0880	.0698	.0553	.04391	.03482	.02762	.02190	.01737
6000	6.974	5.530	4.386	3.478	2.758	2.187	1.734	1.375	1.091	.865	.686	.544	.431	.342	.2713	.2152	.1706	.1353	.1073	.0851	.0675	.0535	.04245	.03366	.02670	.02117	.01679
6200	6.750	5.352	4.244	3.366	2.669	2.117	1.678	1.331	1.055	.837	.664	.526	.417	.331	.2626	.2082	.1651	.1310	.1038	.0823	.0653	.0518	.04108	.03258	.02583	.02049	.01625
6400	6.538	5.185	4.112	3.260	2.586	2.051	1.626	1.289	1.022	.811	.643	.510	.404	.320	.2544	.2017	.1600	.1269	.1007	.0798	.0632	.0501	.03979	.03156	.02503	.01985	.01574
6600	6.340	5.028	3.987	3.161	2.507	1.988	1.576	1.250	.991	.786	.623	.494	.392	.311	.2467	.1956	.1551	.1230	.0975	.0773	.0613	.0486	.03859	.03060	.02427	.01924	.01526
6800	6.154	4.880	3.870	3.069	2.434	1.930	1.530	1.213	.962	.763	.605	.480	.380	.302	.2394	.1899	.1506	.1194	.0947	.0751	.0595	.0472	.03745	.02970	.02355	.01868	.01481
7000	5.978	4.740	3.759	2.981	2.364	1.875	1.486	1.179	.935	.741	.588	.466	.369	.293	.2326	.1844	.1462	.1160	.0920	.0729	.0578	.0458	.03638	.02885	.02288	.01814	.01439
7200	5.812	4.609	3.655	2.898	2.298	1.823	1.445	1.146	.909	.721	.571	.453	.359	.285	.2261	.1793	.1422	.1128	.0894	.0709	.0562	.0446	.03537	.02805	.02225	.01764	.01399
7400	5.655	4.484	3.556	2.820	2.236	1.774	1.406	1.115	.884	.701	.556	.441	.349	.277	.2200	.1745	.1383	.1097	.0870	.0690	.0547	.0434	.03442	.02729	.02164	.01716	.01361
7600	5.506	4.366	3.462	2.746	2.177	1.727	1.369	1.086	.861	.683	.541	.429	.340	.270	.2142	.1699	.1347	.1068	.0847	.0672	.0532	.0422	.03351	.02657	.02107	.01671	.01325
7800	5.365	4.254	3.373	2.675	2.122	1.683	1.334	1.058	.839	.665	.527	.418	.331	.263	.2087	.1655	.1312	.1041	.0825	.0654	.0519	.0411	.03265	.02589	.02053	.01628	.01291
8000	5.230	4.148	3.289	2.608	2.069	1.640	1.301	1.031	.818	.648	.514	.408	.323	.256	.2035	.1614	.1280	.1015	.0805	.0638	.0506	.0401	.03183	.02525	.02002	.01588	.01259
8200	5.103	4.047	3.209	2.545	2.018	1.600	1.269	1.006	.798	.633	.502	.398	.315	.250	.1985	.1574	.1248	.0990	.0785	.0622	.0493	.0391	.03106	.02463	.01953	.01549	.01228
8400	4.981	3.950	3.132	2.484	1.970	1.562	1.239	.982	.779	.618	.490	.388	.308	.244	.1938	.1537	.1219	.0966	.0766	.0606	.0482	.0382	.03032	.02404	.01907	.01512	.01199
8600	4.866	3.858	3.060	2.426	1.924	1.526	1.210	.959	.761	.603	.478	.379	.301	.238	.1893	.1501	.1190	.0944	.0748	.0593	.0470	.0373	.02961	.02348	.01862	.01477	.01171
8800	4.755	3.771	2.990	2.371	1.880	1.491	1.182	.938	.743	.589	.467	.371	.294	.233	.1850	.1467	.1163	.0922	.0731	.0580	.0460	.0365	.02894	.02295	.01820	.01443	.01144
9000	4.650	3.687	2.924	2.318	1.839	1.458	1.156	.917	.727	.576	.457	.362	.287	.228	.1809	.1434	.1137	.0902	.0715	.0567	.0450	.0356	.02830	.02244	.01780	.01441	.01119
9200	4.548	3.607	2.860	2.268	1.799	1.426	1.131	.897	.711	.564	.447	.354	.281	.223	.1770	.1403	.1113	.0882	.0700	.0555	.0440	.0349	.02768	.02195	.01741	.01380	.01095
9400	4.451	3.530	2.799	2.220	1.760	1.396	1.107	.878	.696	.552	.438	.347	.275	.218	.1732	.1373	.1089	.0864	.0685	.0543	.0430	.0341	.02709	.02148	.01704	.01351	.01071
9600	4.359	3.456	2.741	2.173	1.724	1.367	1.084	.859	.681	.540	.428	.340	.269	.213	.1696	.1345	.1066	.0846	.0670	.0532	.0421	.0334	.02653	.02104	.01668	.01323	.01049
9800	4.270	3.386	2.685	2.129	1.688	1.339	1.062	.842	.668	.529	.420	.333	.264	.209	.1661	.1317	.1044	.0828	.0657	.0531	.0418	.0327	.02598	.02061	.01634	.01296	.01028
10,000	4.184	3.318	2.631	2.086	1.655	1.312	1.040	.825	.654	.519	.411	.326	.258	.205	.1628	.1291	.1024	.0812	.0644	.0510	.0405	.0321	.02547	.02020	.01602	.01270	.01007

given last month give the ampere-turns required, per inch of path length, by paths of air, cast iron, cast steel and wrought iron.

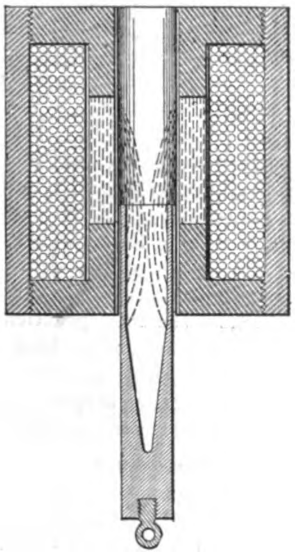
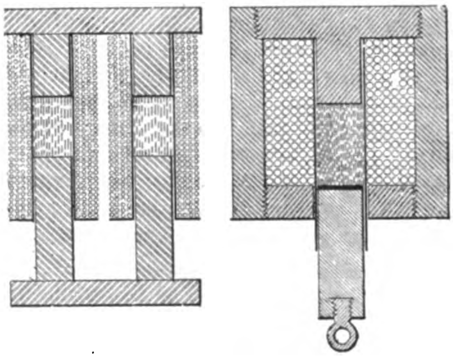


FIG. 4.—IRON-CLAD SOLENOID.



FIGS. 5 AND 6.—STOPPED SOLENOIDS.

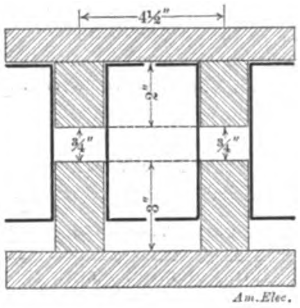


FIG. 7.—CORE DIMENSIONS.

As an example, let us suppose a stopped solenoid like Fig. 5 were given the dimensions indicated by Fig. 7, and a pole-face density of 14,000 lines per square inch were required. The density in the air gap may be considered the same as the pole-face density—14,000; Table I gives 4387 as the number of ampere-turns per inch, so that the total number to force the lines across both gaps will be 1½ × 4387 = 6580½. If each yoke has the same cross-sectional area as the round core, the density there may be also considered to be 14,000, although it will be less because of leakage. The total length of that part of the path which is of iron is practically 19 ins.; at a density of 14,000 the ampere-turns per inch of iron are 4.17, so that 4.17 × 19 = 79.23 ampere-turns will be required for the iron path in addition to the 6580½ for the air-gaps—practically 6660 in all. When the ampere-turns are calculated in this way it is always best to allow for differences in the quality of iron or steel and the effect of leakage by adding about 5 per cent to the result. Thus, in the above case, instead of taking 6660 as the accurate number, it would be advisable to figure the winding for, say, 7000 ampere-turns. It is always best, however, to make the preliminary trial with a temporary winding, as described in the first paragraph above.

Having ascertained the number of ampere-turns required in the coil, the size of wire to be used will depend upon the voltage which it is intended to apply to the terminals of the coil, and to the average length per turn of the winding. The voltage, of course, will be known, and the average length for a coil surrounding a circular core is equal to the circumference of a circle whose diameter is equal to that of the bobbin core plus the thickness of the winding. For example, suppose the magnet core to be used will be 1½ ins. in diameter. Assuming a depth of winding approximately equal to the diameter of the core, the diameter + the depth or thickness of the coil will be 3 ins., so that the mean length per turn will be 9.42 ins. Table 3 herewith shows the relation between the ampere-turns, the mean length per turn of wire, and the size of the wire, for an e.m.f. of one volt at the terminals of the coil. In other words, the values for mean length which are given in the body of the table are the mean lengths of turn per volt. Consequently, in order to use the table, the mean length of turn which the coil will

TABLE IV.—GIVING VALUES OF $\sqrt{\frac{0.00306\ d'}{l\ d^3}}$ MULTIPLIED BY 1000 FOR CONVENIENCE IN SUBSEQUENT CALCULATION. BASED ON DOUBLE COTTON INSULATION.

No. of layers.	Wire sizes: B. & S. Gauge: 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	4.542	4.834	5.148	5.448	5.771	6.096	6.53	6.918	7.375	7.875	8.431	8.982	9.608	.....	.....	.....	.....
2	3.212	3.418	3.64	3.852	4.081	4.31	4.617	4.892	5.215	5.568	5.962	6.351	6.794	.....	.....	.....	.....
3	2.622	2.791	2.972	3.145	3.332	3.52	3.77	3.994	4.258	4.547	4.868	5.185	5.547	.....	.....	.....	.....
4	2.271	2.417	2.574	2.724	2.885	3.048	3.265	3.459	3.688	3.937	4.215	4.492	4.804	5.17	5.507	5.911	6.364
5	2.031	2.162	2.302	2.436	2.582	2.726	2.92	3.094	3.298	3.522	3.771	4.017	4.297	4.624	4.926	5.287	5.692
6	1.854	1.974	2.102	2.224	2.356	2.489	2.656	2.824	3.011	3.215	3.442	3.667	3.924	4.221	4.497	4.826	5.196
7	1.717	1.827	1.946	2.059	2.181	2.304	2.468	2.615	2.788	2.976	3.187	3.395	3.632	3.998	4.163	4.468	4.811
8	1.606	1.709	1.82	1.926	2.04	2.155	2.309	2.446	2.605	2.784	2.981	3.175	3.397	3.655	3.894	4.18	4.5
9	1.514	1.612	1.716	1.816	1.924	2.032	2.177	2.306	2.458	2.625	2.81	2.994	3.203	3.447	3.672	3.941	4.243
10	1.436	1.529	1.628	1.723	1.825	1.928	2.065	2.188	2.332	2.49	2.666	2.84	3.038	3.27	3.483	3.738	4.025
11	1.369	1.458	1.552	1.643	1.74	1.838	1.969	2.086	2.224	2.374	2.542	2.708	2.897	3.118	3.321	3.564	3.838
12	1.311	1.395	1.486	1.573	1.666	1.76	1.885	1.997	2.129	2.273	2.434	2.593	2.774	2.985	3.18	3.413	3.674
13	1.26	1.341	1.428	1.511	1.601	1.691	1.811	1.919	2.045	2.184	2.338	2.491	2.665	2.868	3.055	3.279	3.53
14	1.214	1.292	1.376	1.456	1.542	1.629	1.745	1.849	1.971	2.105	2.253	2.4	2.568	2.764	2.944	3.159	3.402
15	1.173	1.248	1.329	1.407	1.49	1.574	1.686	1.786	1.904	2.033	2.177	2.319	2.481	2.67	2.844	3.052	3.286
16	1.136	1.209	1.287	1.362	1.443	1.524	1.632	1.73	1.844	1.969	2.108	2.245	2.402	2.585	2.754	2.956	3.182
17	1.102	1.178	1.249	1.321	1.4	1.479	1.584	1.678	1.789	1.91	2.045	2.178	2.33	2.508	2.672	2.867	3.087
18	1.071	1.139	1.214	1.284	1.36	1.437	1.539	1.631	1.738	1.856	1.987	2.117	2.265	2.437	2.596	2.787	3.00
19	1.042	1.109	1.181	1.25	1.324	1.399	1.498	1.587	1.692	1.807	1.934	2.061	2.204	2.372	2.527	2.712	2.92
20	1.016	1.081	1.151	1.218	1.291	1.363	1.46	1.547	1.649	1.761	1.885	2.008	2.148	2.312	2.463	2.643	2.846
21	.9912	1.055	1.123	1.189	1.259	1.33	1.425	1.51	1.609	1.718	1.84	1.96	2.097	2.256	2.404	2.58	2.777
22	.9684	1.031	1.098	1.162	1.23	1.3	1.392	1.475	1.572	1.679	1.798	1.915	2.048	2.204	2.348	2.521	2.714
23	.9471	1.008	1.074	1.136	1.203	1.271	1.362	1.443	1.538	1.642	1.758	1.873	2.003	2.156	2.297	2.465	2.654
24	.9272	.987	1.051	1.112	1.178	1.244	1.333	1.412	1.505	1.607	1.721	1.833	1.961	2.111	2.248	2.413	2.598
25	.9084	.967	1.03	1.090	1.154	1.219	1.306	1.384	1.475	1.575	1.686	1.796	1.922	2.068	2.208	2.364	2.546
26	.....	....	1.01	1.068	1.132	1.196	1.281	1.357	1.446	1.544	1.654	1.761	1.884	2.028	2.16	2.318	2.496
27	.....	....	.991	1.048	1.111	1.173	1.257	1.331	1.419	1.515	1.623	1.728	1.849	1.99	2.12	2.275	2.45
28	.....	....	.973	1.03	1.091	1.152	1.234	1.307	1.394	1.488	1.593	1.697	1.816	1.954	2.082	2.234	2.405
29	.....	....	.956	1.012	1.072	1.132	1.213	1.285	1.369	1.462	1.566	1.668	1.784	1.92	2.045	2.196	2.363
30	.....	....	.94	.995	1.054	1.113	1.192	1.263	1.347	1.438	1.539	1.64	1.754	1.888	2.011	2.158	2.324
32	.....	....	....	....	1.02	1.078	1.154	1.223	1.304	1.392	1.49	1.588	1.698	1.828	1.947	2.09	2.25
34	.....	....	....	....	.99	1.045	1.12	1.186	1.265	1.35	1.446	1.54	1.648	1.773	1.889	2.027	2.183
36	.....	....	....	....	.962	1.016	1.088	1.153	1.229	1.312	1.405	1.497	1.601	1.723	1.836	1.97	2.121
38	.....	....	....	....	.936	.989	1.059	1.122	1.196	1.277	1.368	1.457	1.559	1.677	1.787	1.918	2.065
40	.....	....	....	....	.912	.964	1.032	1.094	1.166	1.245	1.333	1.42	1.519	1.635	1.742	1.869	2.012
42	.....	....	....	....	....	....	1.008	1.067	1.138	1.215	1.301	1.386	1.483	1.596	1.7	1.824	1.964
44	.....	....	....	....	....	....	.984	1.043	1.112	1.187	1.271	1.354	1.448	1.559	1.661	1.782	1.919
46	.....	....	....	....	....	....	.963	1.02	1.087	1.161	1.243	1.324	1.417	1.525	1.624	1.743	1.877
48	.....	....	....	....	....	....	.942	.9985	1.065	1.137	1.217	1.296	1.387	1.492	1.59	1.706	1.837
50	.....	....	....	....	....	....	.923	.9784	1.043	1.114	1.192	1.27	1.359	1.462	1.558	1.672	1.80
52	.....	....	....	....	....	....	....	.....	....	.....	.....	1.245	1.332	1.434	1.527	1.64	1.765
54	.....	....	....	....	....	....	....	.....	....	.....	.....	1.222	1.307	1.407	1.499	1.609	1.732
56	.....	....	....	....	....	....	....	.....	....	.....	.....	1.2	1.284	1.382	1.472	1.58	1.701
58	.....	....	....	....	....	....	....	.....	....	.....	.....	1.179	1.263	1.358	1.446	1.552	1.671
60	.....	....	....	....	....	....	....	.....	....	.....	.....	1.16	1.24	1.335	1.422	1.536	1.643

Note:—It is customary to allow only 2¼ sq. ins. per watt for large magnet coils, and allow the correspondingly greater temperature rise. To apply the tables to such magnets, find the length of coil in the ordinary manner and multiply the result by 0.92.

actually have must be divided by the voltage which will be applied at its terminals. The mean length of turn being 9.42 ins., if the e.m.f. at the terminal of the coil is to be 20 volts, then the mean length per volt will be 0.471. Having determined the number of ampere-turns which the coil is to have it is only necessary to trace horizontally in the line opposite this number until the nearest number smaller than 0.471 is reached; the figure at the top of this column is the size of wire to be used for the coil. For example, suppose that the number of ampere-turns required is 3500; tracing horizontally in the table from 3500 in the left-hand column the nearest number to 0.471 is 0.465 and the size of wire at the top of the column in which this number is found is No. 18.

TABLE V.—GIVING VALUES OF $\sqrt{\frac{ml}{C}}$ × AMP. TURNS, DIVIDED BY 1000 TO COMPENSATE FOR THE MAGNIFIED VALUES OF TABLE IV.

Amp. turns.	Ratio of mean length to circumference: ml ÷ C.																		
	.66	.67	.68	.69	.70	.71	.72	.73	.74	.75	.76	.78	.80	.82	.84	.86	.88	.90	.92
1000	.812	.818	.825	.831	.837	.843	.848	.854	.860	.866	.872	.883	.894	.905	.916	.927	.938	.949	.959
1100	.894	.900	.907	.914	.920	.927	.933	.940	.946	.953	.959	.971	.984	.996	1.008	1.02	1.032	1.043	1.055
1200	.975	.982	.989	.997	1.004	1.011	1.018	1.025	1.032	1.039	1.046	1.060	1.073	1.087	1.1	1.113	1.126	1.138	1.151
1300	1.056	1.064	1.072	1.080	1.088	1.095	1.103	1.111	1.118	1.126	1.133	1.148	1.163	1.177	1.192	1.206	1.219	1.233	1.247
1400	1.137	1.146	1.154	1.163	1.171	1.180	1.188	1.196	1.204	1.212	1.220	1.236	1.252	1.268	1.283	1.298	1.313	1.328	1.343
1500	1.219	1.228	1.237	1.246	1.255	1.264	1.273	1.282	1.290	1.299	1.308	1.325	1.342	1.358	1.375	1.391	1.407	1.423	1.438
1600	1.300	1.310	1.319	1.329	1.339	1.348	1.358	1.367	1.376	1.386	1.395	1.413	1.431	1.449	1.466	1.484	1.501	1.518	1.534
1700	1.381	1.392	1.402	1.412	1.422	1.432	1.442	1.452	1.462	1.472	1.482	1.501	1.520	1.539	1.558	1.576	1.595	1.613	1.63
1800	1.462	1.473	1.484	1.495	1.506	1.517	1.527	1.538	1.548	1.559	1.569	1.590	1.61	1.63	1.65	1.669	1.688	1.707	1.726
1900	1.543	1.555	1.567	1.578	1.590	1.601	1.612	1.623	1.634	1.645	1.656	1.678	1.699	1.721	1.741	1.762	1.782	1.802	1.822
2000	1.625	1.637	1.649	1.661	1.673	1.685	1.697	1.709	1.720	1.732	1.743	1.766	1.789	1.811	1.833	1.855	1.876	1.897	1.918
2100	1.706	1.719	1.732	1.744	1.757	1.769	1.782	1.794	1.806	1.819	1.831	1.855	1.878	1.902	1.925	1.947	1.97	1.992	2.014
2200	1.787	1.801	1.814	1.827	1.841	1.854	1.867	1.880	1.892	1.905	1.918	1.943	1.968	1.992	2.016	2.04	2.064	2.087	2.11
2300	1.867	1.883	1.897	1.910	1.924	1.938	1.952	1.965	1.978	1.992	2.005	2.031	2.057	2.083	2.108	2.133	2.157	2.182	2.206
2400	1.950	1.965	1.979	1.994	2.008	2.022	2.036	2.050	2.065	2.078	2.092	2.120	2.147	2.173	2.2	2.226	2.251	2.277	2.302
2500	2.031	2.046	2.062	2.077	2.092	2.106	2.121	2.136	2.151	2.165	2.179	2.208	2.236	2.264	2.291	2.318	2.345	2.372	2.398
2600	2.112	2.128	2.144	2.160	2.175	2.191	2.206	2.221	2.237	2.252	2.267	2.296	2.326	2.354	2.383	2.411	2.439	2.467	2.494
2700	2.193	2.21	2.226	2.243	2.259	2.275	2.291	2.307	2.323	2.338	2.354	2.385	2.415	2.445	2.475	2.504	2.533	2.561	2.59
2800	2.275	2.292	2.309	2.326	2.342	2.359	2.376	2.392	2.409	2.425	2.441	2.473	2.504	2.535	2.566	2.597	2.627	2.656	2.685
2900	2.356	2.374	2.391	2.409	2.426	2.444	2.461	2.478	2.495	2.511	2.528	2.561	2.594	2.626	2.658	2.689	2.72	2.751	2.781
3000	2.437	2.456	2.474	2.492	2.51	2.528	2.546	2.563	2.581	2.598	2.615	2.650	2.683	2.716	2.75	2.782	2.814	2.846	2.877
3100	2.518	2.538	2.556	2.575	2.594	2.612	2.630	2.649	2.667	2.685	2.702	2.738	2.773	2.807	2.841	2.875	2.908	2.941	2.973
3200	2.600	2.619	2.639	2.658	2.677	2.696	2.715	2.734	2.753	2.771	2.789	2.826	2.862	2.897	2.933	2.967	3.002	3.036	3.069
3300	2.681	2.701	2.721	2.741	2.761	2.780	2.8	2.819	2.839	2.858	2.877	2.915	2.951	2.988	3.025	3.06	3.096	3.131	3.165
3400	2.762	2.783	2.804	2.824	2.845	2.865	2.885	2.905	2.925	2.944	2.964	3.003	3.041	3.079	3.116	3.153	3.19	3.225	3.261
3500	2.843	2.865	2.886	2.907	2.929	2.949	2.97	2.99	3.011	3.031	3.051	3.091	3.130	3.169	3.208	3.246	3.283	3.32	3.357
3600	2.924	2.947	2.969	2.990	3.012	3.033	3.054	3.076	3.097	3.118	3.138	3.179	3.22	3.26	3.3	3.338	3.377	3.415	3.453
3700	3.006	3.029	3.051	3.073	3.095	3.117	3.139	3.161	3.183	3.204	3.226	3.268	3.309	3.35	3.391	3.431	3.471	3.51	3.549
3800	3.087	3.11	3.134	3.156	3.179	3.202	3.224	3.247	3.269	3.291	3.313	3.356	3.399	3.441	3.483	3.524	3.565	3.605	3.644
3900	3.168	3.192	3.216	3.239	3.263	3.286	3.309	3.332	3.355	3.377	3.4	3.444	3.488	3.532	3.574	3.617	3.658	3.7	3.74
4000	3.249	3.274	3.298	3.322	3.346	3.370	3.394	3.417	3.441	3.464	3.487	3.533	3.578	3.622	3.666	3.709	3.752	3.795	3.836
4100	3.331	3.356	3.381	3.406	3.43	3.455	3.479	3.503	3.527	3.551	3.574	3.621	3.667	3.712	3.758	3.802	3.846	3.89	3.932
4200	3.212	3.438	3.463	3.489	3.514	3.539	3.564	3.588	3.613	3.637	3.661	3.709	3.757	3.803	3.85	3.895	3.94	3.985	4.028
4300	3.493	3.52	3.546	3.572	3.598	3.623	3.649	3.674	3.699	3.724	3.748	3.798	3.846	3.894	3.941	3.988	4.034	4.079	4.124
4400	3.574	3.602	3.628	3.655	3.681	3.707	3.734	3.759	3.785	3.810	3.836	3.886	3.935	3.984	4.033	4.08	4.128	4.174	4.22
4500	3.656	3.683	3.711	3.738	3.765	3.792	3.818	3.845	3.871	3.897	3.923	3.974	4.025	4.075	4.124	4.173	4.221	4.269	4.316
4600	3.737	3.765	3.793	3.821	3.848	3.876	3.903	3.93	3.957	3.984	4.01	4.063	4.114	4.165	4.216	4.266	4.315	4.364	4.412
4700	3.818	3.847	3.876	3.904	3.932	3.960	3.988	4.016	4.043	4.070	4.097	4.151	4.204	4.256	4.308	4.359	4.409	4.459	4.508
4800	3.899	3.929	3.958	3.987	4.016	4.044	4.073	4.101	4.129	4.157	4.184	4.239	4.293	4.346	4.399	4.451	4.503	4.553	4.604
4900	3.980	4.011	4.041	4.070	4.099	4.129	4.158	4.186	4.215	4.243	4.272	4.327	4.383	4.437	4.491	4.544	4.597	4.648	4.7
5000	4.062	4.093	4.123	4.153	4.183	4.213	4.243	4.272	4.301	4.33	4.359	4.416	4.472	4.527	4.583	4.637	4.69	4.743	4.796
5200	4.224	4.256	4.288	4.319	4.350	4.382	4.412	4.443	4.473	4.503	4.533	4.593	4.651	4.708	4.766	4.822	4.878	4.933	4.987
5400	4.387	4.42	4.453	4.485	4.518	4.55	4.582	4.613	4.645	4.677	4.707	4.769	4.83	4.89	4.949	5.008	5.066	5.123	5.179
5600	4.549	4.584	4.618	4.652	4.685	4.719	4.752	4.784	4.817	4.85	4.882	4.946	5.009	5.071	5.133	5.193	5.254	5.313	5.372
5800	4.712	4.747	4.783	4.818	4.853	4.887	4.922	4.955	4.989	5.023	5.056	5.122	5.188	5.252	5.316	5.379	5.441	5.502	5.563
6000	4.874	4.911	4.948	4.984	5.02	5.056	5.091	5.126	5.161	5.196	5.231	5.299	5.366	5.433	5.499	5.564	5.628	5.692	5.755
6200	5.037	5.075	5.113	5.15	5.187	5.224	5.261	5.297	5.333	5.37	5.405	5.476	5.546	5.614	5.682	5.75	5.816	5.882	5.946
6400	5.199	5.238	5.277	5.316	5.354	5.393	5.431	5.468	5.505	5.543	5.579	5.652	5.724	5.795	5.866	5.935	6.004	6.072	6.138
6600	5.362	5.402	5.443	5.482	5.522	5.561	5.6	5.639	5.678	5.716	5.754	5.829	5.903	5.976	6.05	6.121	6.192	6.262	6.33
6800	5.524	5.566	5.607	5.648	5.689	5.73	5.77	5.81	5.85	5.889	5.928	6.006	6.082	6.157	6.232	6.306	6.379	6.451	6.522
7000	5.687	5.73	5.773	5.814	5.857	5.898	5.94	5.981	6.022	6.062	6.103	6.182	6.261	6.338	6.416	6.492	6.567	6.641	6.714
7200	5.849	5.893	5.937	5.980	6.024	6.067	6.11	6.152	6.194	6.236	6.277	6.359	6.44	6.52	6.599	6.677	6.754	6.83	6.906
7400	6.012	6.057	6.102	6.147	6.191	6.235	6.279	6.322	6.366	6.409	6.451	6.536	6.619	6.701	6.782	6.863	6.942	7.02	7.098
7600	6.174	6.22	6.267	6.313	6.358	6.404	6.449	6.493	6.538	6.582	6.625	6.712	6.798	6.882	6.965	7.048	7.13	7.21	7.289
7800	6.336	6.384	6.432	6.479	6.526	6.572	6.618	6.664	6.71	6.755	6.80	6.889	6.976	7.063	7.149	7.234	7.317	7.4	7.481
8000	6.499	6.548	6.597	6.645	6.693	6.741	6.788	6.835	6.882	6.928	6.974	7.065	7.156	7.244	7.332	7.419	7.505	7.59	7.673
8200	6.662	6.712	6.762	6.811	6.861	6.909	6.958	7.006	7.054	7.102	7.148	7.242	7.334	7.425	7.515	7.604	7.692	7.78	7.865
8400	6.824	6.876	6.927	6.978	7.028	7.078	7.128	7.177	7.226	7.275	7.323	7.419	7.513	7.606	7.699	7.79	7.88	7.969	8.057
8600	6.986	7.039	7.092	7.144	7.195	7.247	7.298	7.348	7.398	7.448	7.497	7.596	7.692	7.787	7.882	7.975	8.068	8.158	8.248
8800	7.149	7.203	7.257	7.31	7.362	7.415	7.467	7.518	7.57	7.621	7.672	7.772	7.871	7.968	8.066	8.161	8.256	8.348	8.44
9000	7.312	7.366	7.422	7.476	7.53	7.584	7.637	7.689	7.742	7.794	7.846	7.948	8.05	8.15	8.249	8.346	8.443	8.538	8.632
9200	7.474	7.53	7.587	7.642	7.697	7.752	7.806	7.86	7.914	7.967	8.02	8.125	8.228	8.33	8.432	8.532	8.631	8.728	8.824
9400	7.636	7.694	7.752	7.808	7.864	7.921	7.976	8.031	8.086	8.141	8.195	8.302	8.408	8.512	8.615	8.717	8.818	8.918	9.016
9600	7.799	7.858	7.916	7.974	8.032	8.089	8.146	8.202	8.258	8.314	8.369	8.478	8.586	8.693	8.798	8.902	9.006	9.108	9.208
9800	7.961	8.022	8.082	8.141	8.199	8.258	8.316	8.373	8.43	8.487	8.543	8.655	8.765	8.874	8.982	9.088	9.194	9.297	9.4
10,000	8.124	8.185	8.246	8.307	8.366	8.426	8.485	8.544	8.602	8.660	8.718	8.832	8.944	9.055	9.165	9.274	9.381	9.487	9.592

As the mean length per volt found in the table does not correspond with the mean length per volt of the coil, the thickness of the coil must be reduced in order to bring its mean length per volt to the value desired. The table shows that No. 18 wire wound to such a diameter as to give a mean length of 0.465 in. per volt will give 3500 ampere-turns to the coil. The voltage must be 20, so that the actual mean length of the coil must be 20 × 0.465 = 9.3 ins. Dividing this by 3.1416 gives the mean diameter which the coil must have, but it is simpler to refer to a table of circumferences and areas, as before; the result is 2 31/32 ins., and subtracting the diameter of the bobbin core (1 17/32 ins.) from this leaves 1 7/16 ins. for the thickness of the winding. In this connection it should be remembered that when the mean length per turn of wire cannot be made exactly what a calculation calls for it should be *less* than the calculated mean length. The reason for this is that with the terminal voltage fixed, the ampere-turns of any coil will be less as the mean length per turn increases; consequently, making the actual mean length greater than its calculated value will result in a weaker magnet than the builder is trying to obtain. It will be found upon calculation that there is no number of layers of No. 18 wire which will give a thickness of precisely 1 7/16 ins.; 29 layers of this size of double cotton-covered wire will give a thickness of 1.44 ins., and as 1 7/16 = 1.4375, the discrepancy is so small that it is not worth while to reduce the actual mean length of the winding by using 28 layers instead of 29.

Having found the size of wire to be used and the corrected mean length per turn that the coil must have, the next point claiming attention is the heating of the coil. Unless it has sufficient external surface to radiate heat at the proper rate, the temperature will be excessive and the coil destroyed. The desired radiating surface can be obtained only by varying the *length* of the coil. With a constant potential at the terminals, the ampere-turns remain practically unchanged irrespective of the length of coil (not length of wire) parallel with the core. For ordinary magnet coils the proper surface, measured around the body and neglecting the heads, may be ascertained by means of the formula:

$$\frac{210\ W}{140 - t} = S \ldots\ldots\ldots\ldots (1)$$

in which W is the number of watts lost in the coil; t is the temperature of the surrounding air and S is the external surface area in square inches. Of course, one cannot change the design of a magnet coil with every change in the surrounding temperature, t; but if this be taken as the average atmospheric temperature in which the coil will work, any increase in atmospheric temperature will not be sufficient to endanger the coil. It is usually quite safe to base heating calculations upon an atmospheric temperature of 70° Fahr. for coils intended to be used in ordinary surroundings; when they are to be used in boiler rooms or other overheated places, the basic temperature should be taken at 100° Fahr. This gives two modifications of the formula, as follows:

Atmosphere at 70°:

$$3\ W = S \qquad (2)$$

Atmosphere at 100°:

$$5\tfrac{1}{4}\ W = S \qquad (3)$$

These formulas show that under ordinary conditions 3 sq. ins. of coil surface will be required for each watt lost in the coil, and 5¼ sq. ins. per watt under boiler room conditions. To satisfy formula (2), the length of the coil parallel with its core may be determined by any one of the following formulas:

$$L = E \times \sqrt{\frac{0.00294\ d'\ d^2}{l\ C\ ml}} \qquad (4);$$

$$L = \sqrt{\frac{0.003\ E\ At\ d'}{l\ C}} \qquad (5);$$

$$L = At \times \sqrt{\frac{0.00306\ d'\ ml}{l\ d^2\ C}} \qquad (6).$$

In these formulas, E is the terminal voltage; At, the ampere-turns; d, the diameter of the bare wire, and d' its diameter over insulation, in mils; C, the circumference of the coil; l, the number of layers of wire, and ml, the mean length per turn. All measurements are in inches except the diameters of the wire. To satisfy formula (3) the numbers 0.00294, 0.003 and 0.00306 in the above formulas must be changed to 0.005147, 0.00525 and 0.005355, respectively.

The easiest one of these formulas to solve without the aid of a slide rule or other calculating apparatus is (5); formula (6) becomes easier to handle, however, with the aid of Tables IV and V. Table IV gives the square root of $0.00306 \div l \times d' \div d^2$, multiplied by 1000 in order to obtain more convenient values, and Table V gives $At \times \sqrt{ml \div C}$, correspondingly divided by 1000. It is only necessary to find in each table the proper value and multiply these two values together in order to find the length of the coil. For example, the stopped solenoid, Fig. 7, required 7000 ampere-turns, or 3500 in each coil. The size of wire was found to be No. 18; the number of layers, 29; the mean length, 9.33, and the circumference of the coil is 13.85 ins. In Table IV the number in the No. 18 wire column opposite the number of layers (29) is 1.784. The mean length ÷ circumference is 0.67365; the nearest to this at the top of Table V is 0.67, and in this column, opposite the ampere-turns (3500) is the number 2.865. Multiplying this by 1.784, obtained from Table IV. gives 5.11, and this is the length of coil necessary to prevent overheating.

As the original intention was to give the cores and air-gap a total length of 5¾ ins., which would be reduced to 5 ins. with the air-gap closed, the short cores would have to be made a little longer in order that the winding may be full 5 inches, and that heads ⅛ or 3/16-in. thick may be used, without having the yoke of the sliding cores strike the coil heads.

In conclusion it may be well to emphasize the fact that the characteristic of a magnet or solenoid cannot be accurately determined without experiment, either as to the pull or the actual heating. However, the tables and data given in this article and in the one printed last month will save considerable time and expense in predetermining the approximate size and power of a traction magnet or a stopped solenoid; and as the assurance that the magnet or solenoid will do the work required of it is much more important than the saving of a small amount of wire or iron, it will be found sufficiently accurate for all practical purposes to use the tables and data without preliminary experiment, by allowing a little margin in final calculations.

Tables III, IV and V may be used for solenoids of the common open type, after a preliminary test for ampere-turns, but only Table III can be used for the iron-clad type (Fig. 4) because its winding is not exposed to the air.

In cases such as the electromagnets of an arc lamp, where it is desired to keep the size of the magnet down to the smallest possible dimensions and at the same time guard against serious overheating, the tables will only serve as a preliminary guide in approximating the dimensions and winding of the magnets, after which the permanent dimensions and windings will have to be determined from experiment with a temporary magnet built from this preliminary data. For the purpose of rewinding the field magnets of a dynamo, the tables are sufficiently accurate without making any preliminary experiment other than exciting the magnet by means of a temporary winding in order to ascertain the minimum number of ampere-turns required. Having obtained this value, the tables may be used without further experiment and without any allowances. The voltage at the terminals of the entire shunt winding, however, should be taken as 10 per cent less than the no-load voltage at the brushes, and this value divided by the number of magnet coils to ascertain the voltage at the terminals of one coil.

In last month's article, near the top of the first column on page 157, the statement "only a few magnetic lines go over to the armature, most of them going around the outside of the coils to the yoke;" should read "only a few magnetic lines go over to the armature, most of them going *across from pole to pole* and around the outside of the coils to the yoke."

ELECTRICALLY CONTROLLED BULKHEAD DOORS.

BY GEORGE E. WALSH.

The evolution of the water-tight bulkhead for ships from the old wooden types of half a century ago to the modern steel constructions represents progress along certain lines of shipbuilding that is of more than passing note. Theoretically the bulkhead question was settled years ago, but it has needed only new shipwrecks and disasters at sea to convince marine architects that practically the devices were inadequate. When a ship meets with a serious accident at sea the necessity of closing the bulkhead doors quickly becomes paramount, and the existence of the ship and passengers may depend entirely upon the celerity with which this can be accomplished. The repeated failures of bulkhead doors to close promptly enough to save the ship have caused dissatisfaction and anxiety in many quarters, but nowhere more than among marine architects and shipowners.

The theory of water-tight bulkheads is simple and its application should be practicable; the stumbling-block has been in the doors which lead through the bulkheads.

There are upward of twenty and thirty bulkhead doors in a large steamer, and it may be necessary to close one or all on short notice. The mechanism which operates these doors must be beyond any chance of getting out of order. More than one disaster has been caused by the mechanism refusing to work when urgently needed, and the criticism has in some such cases been directed toward the bulkheads instead of the mechanism which controlled the doors. To meet an emergency it should be possible to close the doors of all the bulkheads either below decks or at some directing point above. The time required for an officer to go below decks to close the bulkhead doors has more than once been sufficient to give the water a chance to fill several compartments, and thus defeat the object of the water-tight compartments.

Both the hydraulic and pneumatic methods of controlling the bulkhead doors have proved failures, or at least uncertain enough to involve an element of danger. The hydraulic apparatus for operating bulkhead doors has been largely abandoned in modern shipbuilding, because of the unsatisfactory results obtained. The pneumatic system still has its advocates, and for the present it may hold its own. But there is danger in the use of either air or water for this all-important work. Both air and water must be conducted through pipes, valves and other complicated apparatus, and not only may these become disabled, but the air and water will, in time, leak out of them. Electricity is peculiarly well adapted to the performance of this work on a steamer. One great thing in its favor is that a sudden and great power can be exerted at a critical moment, exceeding often by far the normal rated power of the apparatus. This is important when it is necessary to close the doors simultaneously or in rapid succession. Electricity is used so generally on shipboard now for a great variety of purposes that a new auxiliary source of power does not have to be installed to control the bulkhead doors in an emergency. Indeed, at the critical moment, the full power of the existing electric plant could be exerted to close the doors, and the force would always be ready for an emergency without entailing waste or loss.

In many ways electricity is superior for operating bulkhead doors, and it only needed a practical invention to make this agent the generally accepted one in the navy and on merchant steamers. There have been in operation now for nearly a year electrically-controlled bulkhead doors on the United States cruiser "Atlanta." The apparatus was devised by Naval Constructor Francis T. Bowles, of the Brooklyn Navy Yard, and a model of it was placed on exhibition in the War Material Building at the Paris Exposition. So successful has this apparatus proved that the Navy Department has decided to equip all future warships with the electrical mechanism, while many of the warships now in service will gradually be changed also in this respect. Electrically-operated bulkhead doors have been adopted by some of the ocean merchant steamers, notably the "St. Paul," and its general adoption in the merchant marine seems only a question of time.

The electric bulkhead door possesses many features of a novel and unique nature. It is so wired that the officer in charge can operate it from the bridge, and by pushing a button he can tell at any moment the condition of the door. A tiny lamp near the button indicates whether or not the door is in good working order. When the door is closed the lamp is dark, as the current is automatically cut off. One or a dozen doors can be closed simultaneously or in rapid succession. The full power of all the motors can be concentrated upon one door if the necessity arises, making it possible to drive the door into a closed position against a tremendous opposition by inflowing water.

In addition to the control the navigating officer may have on deck, there is a local control below decks which takes precedence over the first in an emergency. The officer between decks may find it necessary to go through the door, and the delay caused by communicating with the officer on deck might prove fatal. He can consequently open or close the door by hand, and when he has passed through, the control on the bridge is immediately restored. Controlling stations can be distributed over different parts of the ship, so that in an emergency some one would surely be within easy reach of a push button.

The speed of operation and practically absolute assurance that the doors will close are the two greatest features of the system. Doors can be closed in ten seconds, and with such obstructions as coal, wood, paper and water in the way they have been closed in numerous experiments in from half a minute to one and a half. Tests already made indicate that the danger of improperly controlled and working bulkhead doors will no longer neutralize the advantage conferred by the provision of water-tight compartments on board ship.

A French Corliss-Type Steam Engine.

Among the high-economy steam engines built by European manufacturers for electrical service, a particularly interesting one is that of Dujardin & Co., Lille, France, the horizontal triple-expansion type of which is illustrated herewith. The engine here shown was built to drive a 1000-kw. alternator, the rotating member of which is mounted midway on the crank shaft, as indicated by Fig. 5, which is a plan view of the engine. There are two low-pressure cylinders, one mounted in tandem to the high-pressure cylinder, and therefore delivering power in common with that cylinder to one of the crank shafts, while the other low-pressure cylinder is arranged in tandem with the intermediate cylinder and delivers power to the second crank; the two cranks are displaced 90° from each other, as usual.

All of the cylinders are steam-jacketed, the high-pressure jacket taking steam direct from the boiler on both sides and the cylinder heads. The other cylinders and the intermediate receivers, of which there are two, are jacketed with steam which has been expanded to a little over one-half of the initial pressure, so that its temperature is still considerably above that of the exhaust from the high-pressure cylinder into the first receiver. The volume of the first receiver is 1.8 times the displacement per stroke of the high-pressure piston; the second receiver has a volume equal to the displacement per stroke of the intermediate piston. The high-pressure cylinder is 24 ins. in diameter, and all three of the others are 41 ins. in diameter; the stroke is 5 ft. 5 ins. The normal speed of the engine is 72

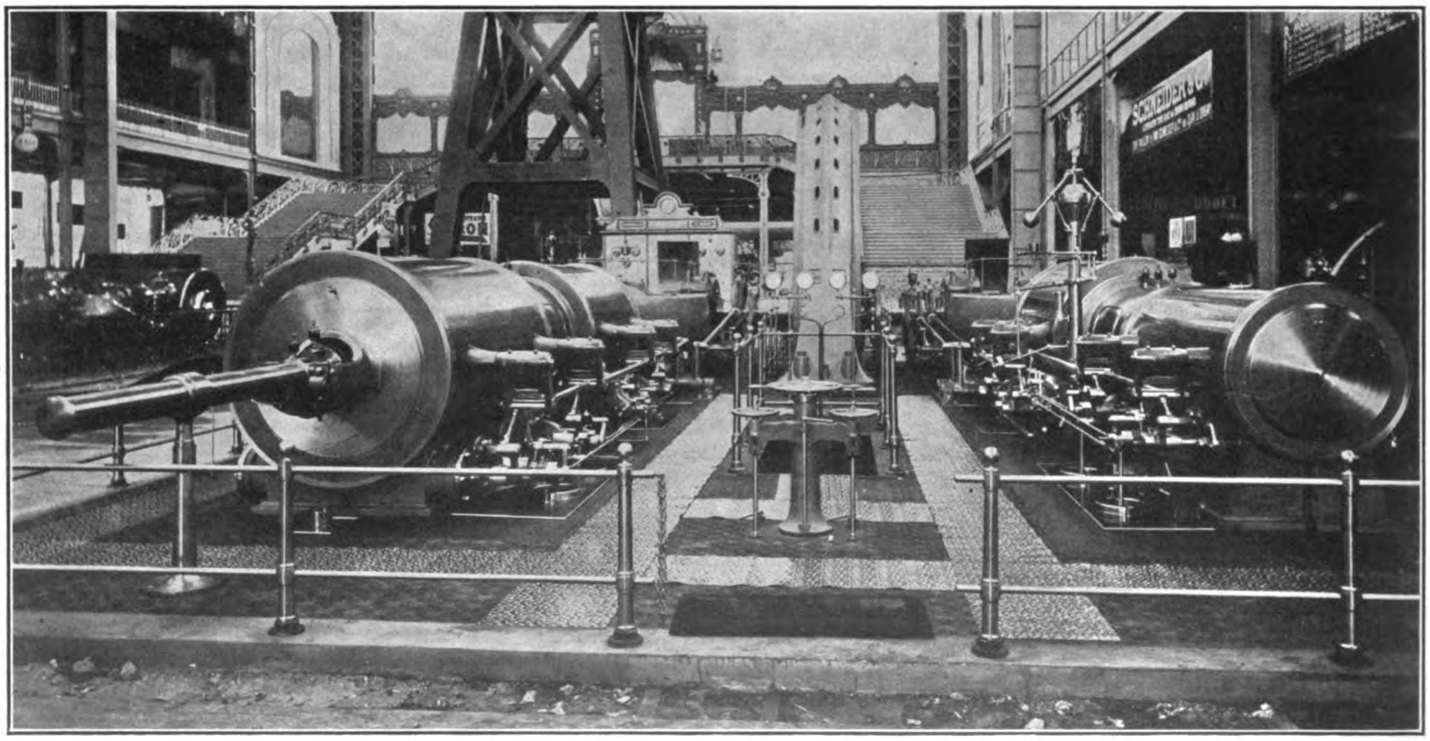


FIG. 1.—HORIZONTAL TRIPLE EXPANSION ENGINE DRIVING 1000-KW. ALTERNATOR.

r.p.m., so that the average piston speed is 780 ft. per minute. With steam at 160 lbs. boiler pressure and the cut-off giving 19 expansions, the engine indicates 1700 horse-power. As indicated in Figs. 1 and 5, the piston rod of the intermediate cylinder is extended into a tail-rod, and this has a bearing in a guide external to the cylinder, so that the gland is not depended upon to keep the rod in alignment.

A feature which is somewhat unusual in European engines is the placing of all four valves, which are of the Corliss type, beneath the cylinder. The admission and exhaust valves are arranged in pairs very close to each other, as indicated in the upper part of Fig. 2, the exhaust valves being nearest the ends of the cylinder. Three eccentrics are used on the high-pressure side of the engine. One of these drives positively the four valves of the low-pressure cylinder on that side, through very simple mechanism, indicated by the letters, *L*, *L*, in Fig. 2. Another eccentric drives the four valves of the high-pressure cylinder, the exhaust valves positively and the admission valves through a trip gear. The third eccentric gives a reciprocating movement to the trip or cut-off gear.

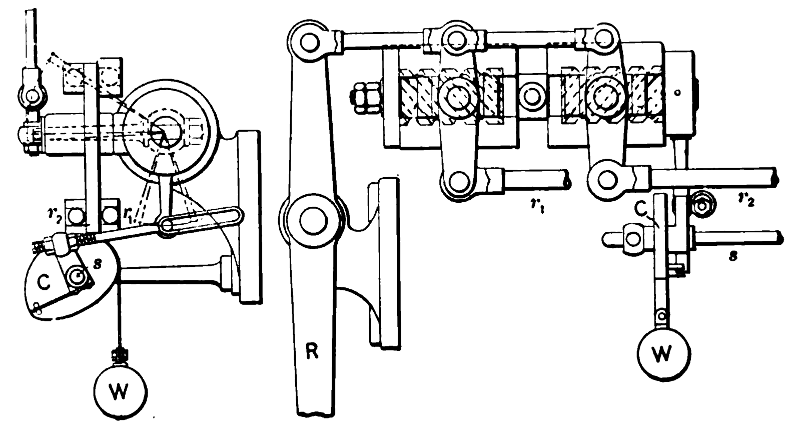


FIG 3.—DETAILS OF GOVERNOR MECHANISM.

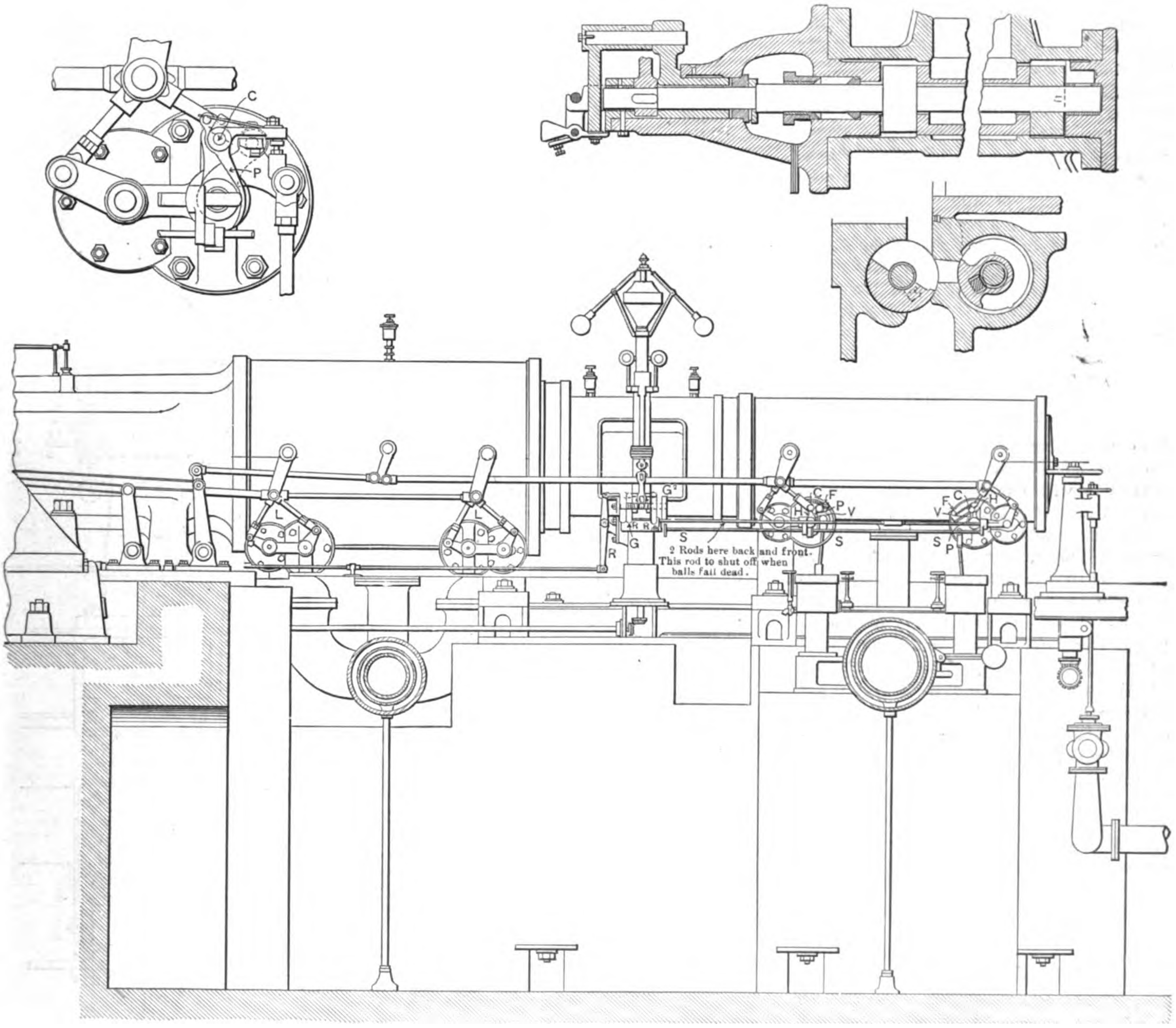


FIG. 2.—PLAN AND DETAILS OF VALVE GEAR.

The trip for releasing one of the admission valves is shown at the upper central part of Fig. 2. The arm, *H*, is oscillated in exactly the same manner as the rocker arm on the exhaust valve stem and the arms on the low-pressure valve gear. The pin, *O*, on this arm, carries a trigger, *T*, and pallet, *P*, cast in one piece. The pallet, however, lies in a plane outside that in which the trigger oscillates. The outer end of the trigger is provided with a hardened-steel lip which engages the arm, *V*; this arm is keyed to the valve spindle, so that the valve is rocked by the arm, *H*, through the intermediation of the trigger, *T*. The release is effected by means of the pallet, *P*, which is curved to a long special sweep. The concave surface of this pallet rests upon a rounded hard-steel head, which is mounted on the end of one of the cut-off rods. There are two of these rods, one serving the trip gear at each end of the cylinder.

The point of trip is varied by means of the right and left-hand spiral gear shown in Figs. 3 and 4. The rocker arm, *R*, is oscillated by the third eccentric, previously referred to, and imparts an oscillating motion through the trip rods, r^1, r^2. The rocker arms to which these rods are pivoted are fulcrumed on two blocks, the distance apart of which is regulated by right and left-hand screw threads on the spindle passing through the blocks. The governor gear is arranged to rock this spindle and thereby vary the distance apart of the fulcrums and consequently the time when the trip rods, r^1 and r^2, actuate the pallets at the valve gear and release the admission valves. The trip rod, r^1, lifts the pallet and trigger at the left-hand end of the cylinders in Fig. 2, and the rod, r^2, actuates the pallet at the right-hand end of the cylinder. The mechanism through which the governor controls the trip gear is shown in Fig. 4. The governor is of the ordinary fly-ball type and rocks the right and left-hand screw through a simple system of levers. A cam, *C*, and weight, *W*, shown more plainly at the left of Fig. 3, are arranged to operate the right and left-hand screw so as to prevent any admission of steam to the cylinder, in case of any accident to the governor. The trip gear is said to give a range of cut-off from 0 to 70 per cent of the stroke, which will be recognized as an unusual range for this class of valve gear.

The valves of the intermediate cylinder are equipped with exactly the same mechanism as that just described for the high-pressure cylinder, except that the point of cut-off is regulated by hand instead of by the governor. Two eccentrics are used on this side of the engine, one to drive all of the valves on both cylinders, and the other to drive the trip mechanism just described in connection with the high-pressure cylinder. The admission and exhaust valves of each cylinder are of equal size. The high-pressure valves are 6.7 ins. in diameter, and all of the other valves are 9.84 ins. in diameter. The areas of the admission and exhaust ports of each cylinder are different, however, the exhaust ports being longer than the admission ports. In the high-pressure admission ports the steam velocity is about 7500 ft. a minute, and in the exhaust ports of this cylinder the velocity is about 6500 ft. a minute. In the intermediate cylinder ports the admission steam has a velocity of about 8500 ft. a minute, and the exhaust steam about 6200 ft. a minute. For the low-pressure cylinder the velocities are 8800 and 5600 ft. per minute for the admission and exhaust respectively.

There are two jet condensers, one at each side of the engine, and each condenser is served by two air pumps. The pumps are vertical, with three sets of suction, bucket and delivery valves. Each pair of pumps is driven from one of the engine cross-heads through the medium of a double bell-crank lever, the long arm of which extends downward from the cross-head link to the lever shaft on each side of which the horizontal arms of the double bell-crank rock up and down, forming a sort of walking beam. From the outer ends of this walking beam are hung the connecting rods of the pumps. Each cylinder is single-acting, but as there is a pair of cylinders the effect is the same as though a single double-acting pump were used, the two cylinders drawing water from the condenser alternately. Each of the air-pump cylinders is 21.65 ins. in diameter and 13.78 ins. stroke, so that the theoretical displacement of all of the pump buckets is 0.0526 of the displacement of both of the low-pressure pistons. The volume of each condenser is 1½ times the

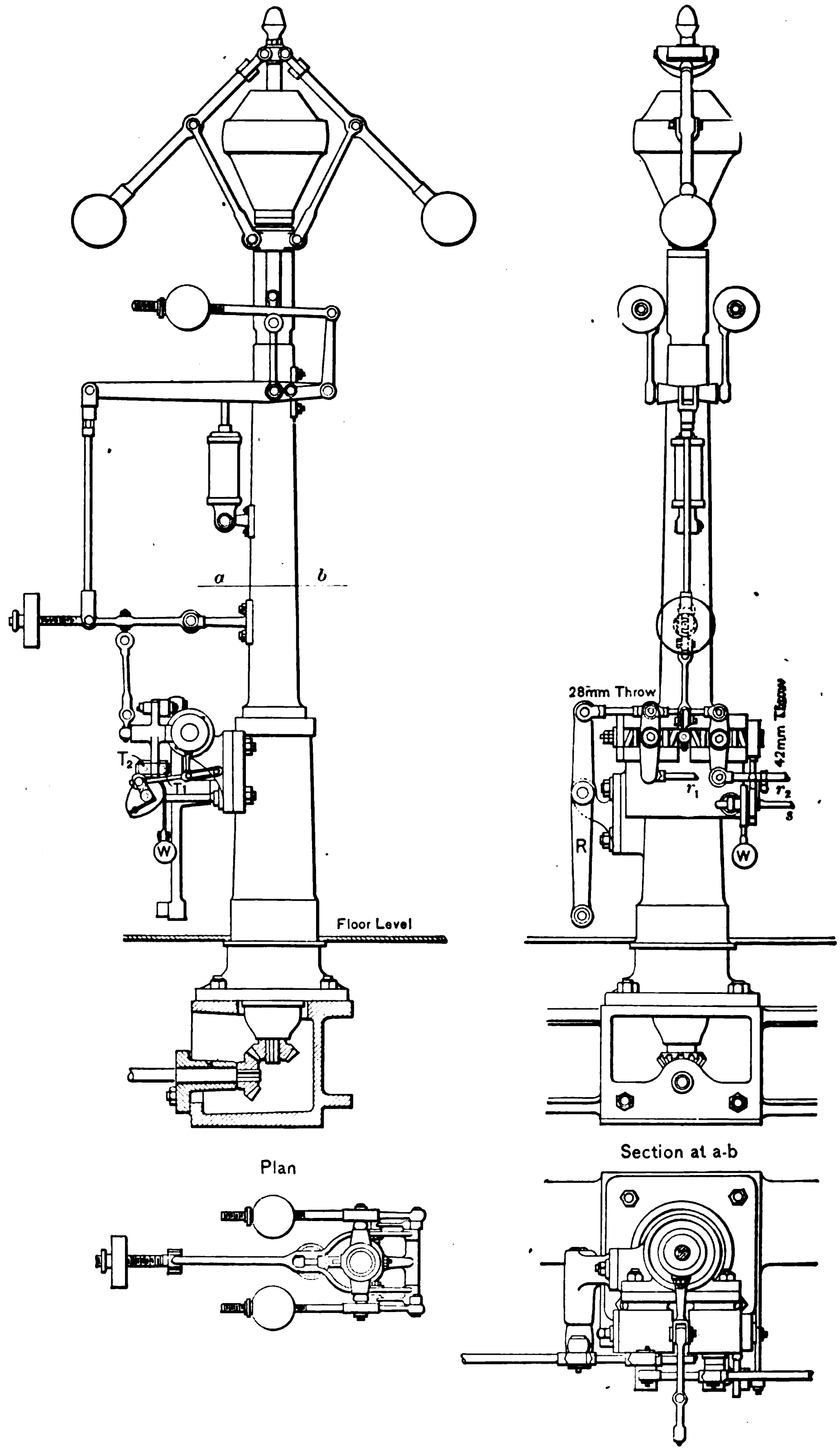


FIG. 4.—PLAN AND DETAILS OF GOVERNOR.

displacement per stroke of one of the low-pressure pistons. One of these engines was exhibited at the Paris Exposition, where it drove a 1000-kw. Schneider alternator supplying three-phase currents at 3000 volts and 50 cycles. The perspective view (Fig. 1) was made from a photograph of this combined generating unit.

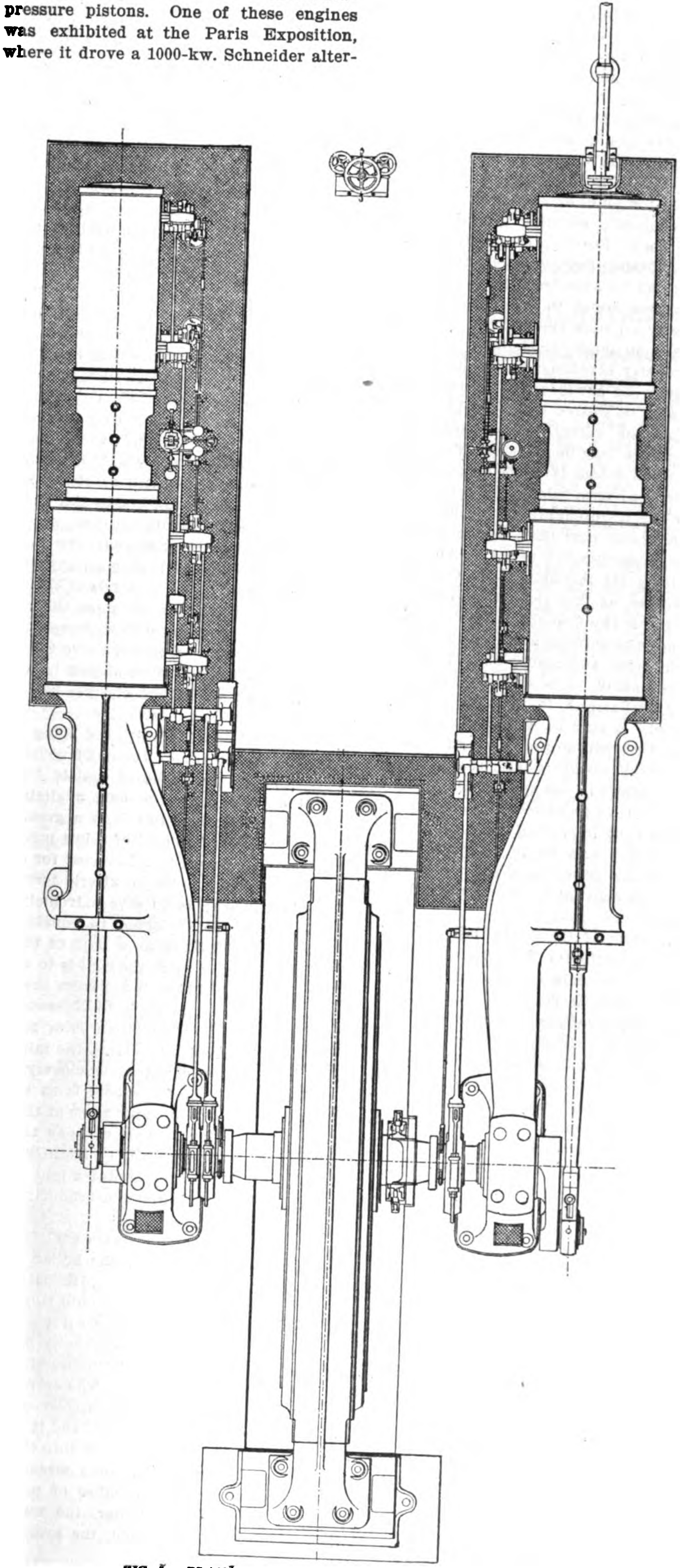


FIG. 5.—PLAN VIEW OF ENGINE AND ALTERNATOR.

ECONOMY IN STEAM PRODUCTION.

BY C. W. OBERT.

Economy in the production of steam is not necessarily secured by installing a modern plant with high-grade boilers, auxiliaries, etc. It depends as much upon the proper handling and care of the machinery as upon its grade; and perhaps more. The highest possible economy is secured only when the apparatus is operated under the very best conditions. The average steam engine, with its perfection of detail and the careful attendance it usually gets, operates under extremely favorable conditions, so that it is not uncommon to find an engine developing a horse-power with a consumption of from 10 to 15 lbs. of steam an hour. But the average boiler, with the lack of intelligent care and dark, dirty surroundings which are regrettably common, usually operates under very unfavorable conditions, and is undoubtedly the most wasteful portion of the power plant—a result which is altogether unnecessary.

The cost of generating steam in a boiler is made up of several factors, each of which involves and is governed by mere details. The location of the boiler has primarily a very important bearing on economical results, and too little attention is paid to it. If it is necessary that the boiler be placed in a cellar or dark room, its surroundings at least should be kept just as clean and bright as possible. The tendency is unfortunately to allow the walls, windows and surroundings to remain dirty and dusty without any more cleaning than is absolutely unavoidable, and the boiler and everything connected with it are sure to follow into that same uncared-for state of inefficiency. Relatively as much exertion should be spent in "shining up" the boiler fittings and cleaning the boiler room as is spent on the engine and engine room. A clean, brightly-painted room lends an incentive to keeping fittings clean and to giving the boiler proper care; furthermore, plenty of light makes it much easier to inspect and clean the boiler and flues thoroughly. Even if a boiler room is necessarily small and dark there is no reason why gauges, valves, injectors, and all other fittings should not be kept polished bright and in good working order, and all important parts and fittings adequately illuminated by means of artificial light.

The internal condition of the boiler is probably the most important factor in the steam-making problem; cleanness is nowhere so profitable as inside a steam boiler. Actual tests have shown an evaporation of from 7 to 8 lbs. of water per pound of coal in a thoroughly cleaned boiler, while with one-eighth of an inch of scale the evaporation was reduced in the same boiler to between 4 and 5 lbs. of water per pound of the same coal; the cost of steam being nearly doubled by the very small accumulation of scale mentioned. Thus, the importance of cleaning the boiler thoroughly and often cannot be over-estimated, although much too frequently it is neglected or cared for by the baneful method of "blowing off hot." In blowing off hot, all scale that is not readily washed out by the outflow of water will dry and bake on the heating surface in cakes which it is difficult to remove when they are once solidified. This pernicious method will also do more harm to the boiler, in the way of straining seams and loosening tubes by the sudden contraction, than would follow from years of service. A boiler should always be allowed to cool down before the blow-off valve is opened. Then, when the manholes and hand-holes are opened, it will be found that the sediment on the flues and shell is soft, sludgy and easily washed off with a hose. If the supplementary washing off is neglected, this sludgy sediment settles upon the heating surfaces and is gradually baked hard, after which it can be removed thoroughly only by chipping out with a scale pick.

The formation of this sludge, which subsequently bakes into scale unless washed out, is unavoidable unless pure feed water can be obtained, and this, of course, is rarely possible. If incrustation forms and it is inconvenient to shut the boiler down for cleaning, it may be advisable to have the feed water analyzed by a reliable chemist, and then treat it chemically to remove the impurities revealed by the analysis; or, better yet, to use a feed-water purifier of the lime-catching type. Such a purifier will remove practically all solids that are present in feed water by simply heating the water to the temperature at which it precipitates all or most of its solid matter.

For the same reason that renders scale objectionable (the impairment of heat-transferring efficiency), the outside of the heating surfaces should receive as much attention as the inner or water side. In practice, the outer surfaces usually receive much more attention than the interior on account of being easier of access, but the cleaning of these surfaces is also too often done indifferently. The soft deposit or coating of soot which forms very rapidly on the fire side of heating surfaces cannot be prevented, but must be cleaned off frequently. The under side of the boiler shell may easily be scraped and then swept off, but it should not be swept only, because sweeping alone may not thoroughly remove the deposit. For the flues a scraper is necessary, even when a "soot-sucker" or blower is used, as a steam or air jet rarely if ever thoroughly cleans a flue. If the fuel is such that the soot is at all tarry or sticky, the soot must be scraped out, as it can be removed in no other way. The arrangements for cleaning the flues should be made as convenient and complete as possible, in order to facilitate the performance of the work in a careful and thorough manner. In many boiler rooms a folding staging is arranged so as to be easily placed in front of the flue door, and this facilitates thorough and rapid work. Too much attention cannot be paid to this matter of cleaning the boiler inside and out, as this is probably the most important factor in steam production from the viewpoint of economy.

The draught is also an important factor in the cost of steam production. A draught suitable for one coal may not be suitable for another; for instance, a fine coal requires a stronger draught than a coarse coal. For this reason the damper in the chimney flue should be arranged so that it can be adjusted from a point near the furnace doors, in order that the fireman may regulate the draught to suit his coal and to meet the demand for steam. By properly checking the draught, much coal may be saved at times that would otherwise be wasted by steam blowing off through the safety valve; moreover, a checked fire may be more quickly "opened out" when steam is needed again than if the fire had been allowed to die down.

For the maintenance of a good draught it is essential that the brickwork about a boiler be maintained perfect. Any cracks admitting air through the setting should be stopped, as they tend to cool the boiler and impair the draught. All brick settings are liable to settling as well as disintegration by heat, and cracks should be looked for frequently. It is well to have the masonry refinished if it has settled or cracked. A coat of whitewash applied to the setting will stop up enough imperceptible cracks to more than pay for the expense. Doors in the setting very frequently give lots of trouble by not closing tightly, and thus impairing the draught greatly, but they can easily be made tight by stuffing the edges with sheet asbestos or any other convenient non-combustible material.

All parts of the boiler not covered by brickwork should be carefully covered with a non-conductor of heat. If the top of the boiler is set so that it cannot be covered by strong cement mortar, it should be covered with magnesia, asbestos, or a cement of some suitable non-conducting material. Exposed steam surfaces may condense from one-third to one-half a pound of steam per square foot per hour or more if exposed to air currents, and thus very materially increase the cost of steam delivered. A good covering 1 in. thick will reduce this condensation loss about 80 per cent. An example of the economy resulting from a covering may be given by considering 100 sq. ft. of exposed steam surface. With condensation at the rate of ½ lb. of steam per square foot per hour, there would be a loss of 50 lbs. of steam per hour, 1200 lbs. per day of 24 hours, or 432,000 lbs. per year of 360 days. Assuming that 1 lb. of coal produces 7 lbs. of steam, this would represent a waste of nearly 31 tons of coal, or $75 to $90. Eighty per cent. of this might be saved with a good covering, so that upon investment of from $15 to $25 for 100 sq. ft. of covering, a saving of from $60 to $70 would be effected in a year. Even if the boiler were fired only 10 hours a day, the covering would save its own cost in a year. This argument applies to steam pipes, valves and fittings as well as to the boiler top and dome.

Another very important factor is that of the firing. Good economy may be obtained in firing by closely watching the steam and water gauges and the judicious use of the damper and boiler feed, in contrast with the too general method of simply crowding in all the coal possible with the least effort. It has been said that the waste due to improper firing is often greater than any other loss in the operation of a steam plant. If the proper conditions of good draught, an even fire, and systematic, even firing be observed, as high economy should result by hand firing as is obtained with mechanical stokers. In marine boiler firing on the Great Lakes the firemen spread their coal evenly over the entire grate at each firing, and they produce steam economically; while firemen on many coastwise steamers on the Atlantic pile up the coal just inside the furnace door, and, as it becomes coked, spread it back over the incandescent fire behind, and obtain fully as high economy as the Lake firemen. These methods of firing are equally good, but in all cases the grate-bars should be kept entirely covered, and the amount of air required above the grate for complete combustion should be admitted from above instead of from below the grate.

Equally important with the firing is the quality and price of fuel. Of course the selection of the grade of coal to be used will depend upon the coal available, as well as its price. But it is a great mistake to think that coal of a low price will necessarily result in a low cost for steam. A cheap coal may be so utterly poor from shale and dirt as to give extremely poor results. It is advisable to consider the question of freight as a part of the coal cost, especially when the coal is to be used at a considerable distance from the mine. A coal that is worth 60 to 75 cents a ton at the mine may be worth $3 or $4 a ton several hundred miles from the mine, due to the freight charges. Obviously, when the actual cost of the coal is so small a percentage of its market price at the point of consumption it does not pay to buy a cheaper coal, as a coal of slightly higher price at the delivery point might mean a coal of double the steam-producing quality.

The best way to select a coal is to test it in actual use under the boiler in comparison with other grades. Sufficient coal of the kind to be tested should be obtained and a ten-hour test made with it under the boiler, which will show exactly what the coal is capable of doing under the actual conditions of operation. The carrying out of such a test is comparatively simple if a platform scale is at hand and it is possible to insert a thermometer into the boiler feed-water pipe. The only measurements necessary are the number of pounds of water fed to the boiler, the number of pounds of coal burned, the average temperature of the feed water and the average steam pressure in the boiler; from these, providing the test is started and stopped with the boiler under exactly the same conditions as to height of water, steam pressure, etc., the actual number of pounds of water evaporated by a pound of the coal on trial may be calculated. Then a similar test should be made with another coal to be compared, care being taken to maintain the steam pressure and feed-water temperature as nearly as possible the same as they were in the first test. This sort of comparative testing will furnish a clear idea as to the relative merits of two or more kinds of coal, and has been used in some places with great economic advantage. In one instance, a coal that was thought to be the best grade obtainable did not show as high evaporation as cheaper coal with shale in it, and in other instances cheap coals have been proven less economical than higher-priced coals.

Abstracts from Foreign Contemporaries

Motor-Driven Feed Pump.—While an electrically-driven pump is superior to a steam-driven pump in point of efficiency, the usual method of motor regulation by rheostat entails a considerable waste of power. In the Mather & Platt pump illustrated by Fig. 1 and described in a recent issue of the London "Mechanical Engineer," the regulation is entirely mechanical, consisting of altering the stroke of the plungers according to the required output; the result being that the electrical power consumed is very nearly proportional to the work done by the pump. The pumps can be driven by either direct-current or polyphase motors; each pump consists of three cylinders mounted radially on a frame at angles of 120° with each other, with plungers driven from a crank pin by connecting rods. The crank pin is arranged eccentrically on a disc fitted into a recess in an internal toothed wheel which engages a pinion on the motor shaft. The rotation of this disc causes the desired alteration of the stroke and it is obtained by gears situated in the hub of the internal wheel operated by a suitable hand lever. An indicator fixed to the regulating device shows the length of the stroke which is in operation and therefore the corresponding output of the pump at the time. Raising the hand lever alters the stroke and when the desired rate of discharge is indicated the lever may be released. The motor is steel-clad with the windings entirely protected from injury.

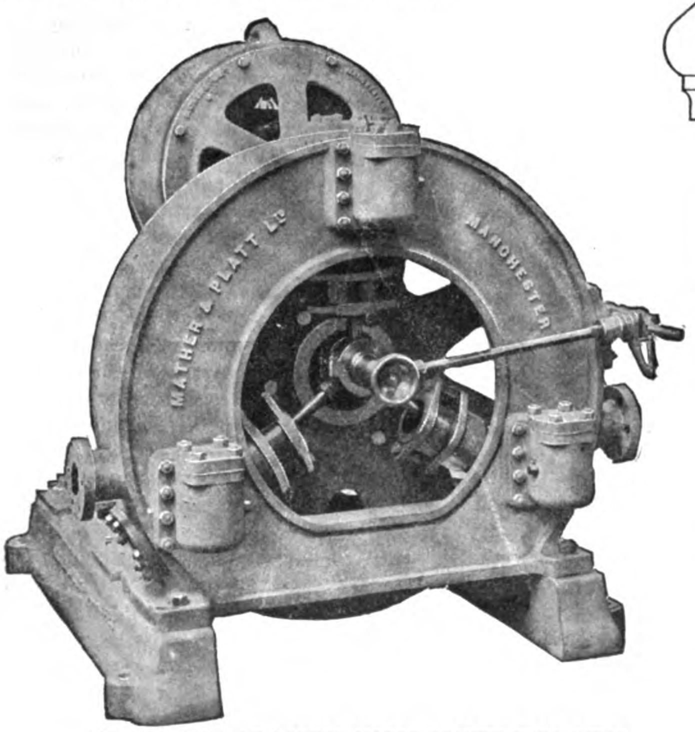


FIG. 1.—CONSTANT SPEED MOTOR-DRIVEN FEED PUMP.

Alternating Arc Lamp for Series Circuits.—A recent issue of the London "Electrician" contains a description of a new alternating-current enclosed arc lamp for series circuits, designed by Frank Lewis, a diagrammatic view of which is shown by Fig. 2. The lamp is of the clutch type, a notable feature being the use of a subsidiary and powerful brake operating on the striking lever, and taking the place of the usual dash-pot. The brake comes into play when the arc is struck and whenever the current exceeds the normal. The lamp circuit is shunted by a choke coil capable of taking all of the current in case the arc should break; the voltage at the terminals of the other lamps remaining fairly constant. The action of the lamp is as follows: Two solenoids, A and B, are in series with the arc. Upon switching on the current, the core, C, is drawn into the solenoid, A, and the arc is struck by the clutch, D. At the same time the core, E, is drawn into the solenoid, B, raising the lever, F, and pressing the shoe, G, against the block, H, on the striking lever. This prevents the core, C, from being raised too quickly and hunting. The act of striking being slow, the arc attains its full length after 30 seconds. When the arc is fully established and the current normal, the core, E, and the shoe, G, drop, the core floating in the solenoid. It is claimed that the light is of a better color, owing to the small inductance and the hard, gritty nature which the ends of the carbons assume. It is also claimed that the candle-power is higher for a given consumption of energy, and that the lamp is not affected by vibration owing to the quickness with which the braking apparatus comes into operation. The total current required is 9 amperes at 80 volts.

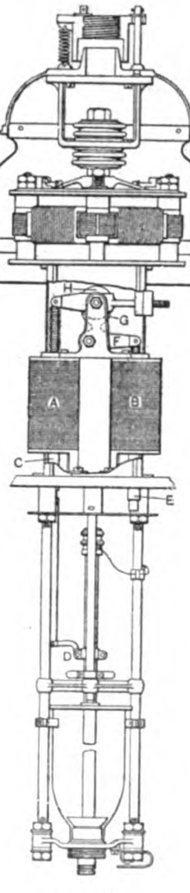


FIG. 2.

Clearance and Compression in Steam Engines.—The study of the effect of compression in the cylinder of an engine upon the steam consumption has received an impetus since the announcements of the unexpected results obtained by Prof. Dwelshauvers-Dery in his experiments on the engine at the University of Liége. The latest of the papers on this subject is one by Mr. H. Dubbel in a recent issue of the "Zeitschrift des Vereines deutscher Ingenieure," giving a review of all the important research work which has been done in Europe and America in connection with clearance and compression. The experiments of Dwelshauvers-Dery showed marked losses with increased clearance and corresponding compression, which is contrary to the accepted statement of Zeuner, who maintained that the injurious effect of clearance could be entirely overcome by compressing the exhaust up to boiler pressure. Experiments by Doerfel upon a Corliss engine using widely varying degrees of increased compression showed that the loss due to initial condensation was diminished by increased compression. Mr. Dubbel gives a tabulated extract of the classic experiments of Prof. Dwelshauvers-Dery and appends the data and results of experiments made by Profs. Barr and Carpenter at Cornell University and Prof. Jacobus at Stevens Institute, all of whom show that for degrees of compression ranging from 11 to 35 per cent bringing the compressed exhaust steam from ⅝ to full initial pressure, the steam consumption per horsepower was not materially altered. Weighing all the conditions carefully, the author concludes that the experiments of Doerfel, Barr, Carpenter and Jacobus are entitled to acceptance, and that there is little or no loss in steam consumption with increased compression. He attributes the results of Prof. Dwelshauvers-Dery to leaky valves and piston.

Insulating Varnish.—Interesting results obtained at the Imperial Physical Technical Institute of Charlottenburg, Germany, with paper coated with "Armacell" varnish and tested to determine its resistance to puncture at high pressures, are given in a recent issue of the London "Electrical Engineer." The paper was coated and baked twice with the varnish, and placed one sheet after another between two round brass electrodes and connected to an accumulator battery system. The voltage was then gradually increased until the paper broke down. In cases where the paper did not break down at the highest direct-current voltage available, which was 11,000 volts, the electrodes were connected to the terminals of an alternating transformer. The results of the test are tabulated in the table herewith:

No.	Thickness in inches.	Resistance between the electrodes at 1000 volts, 75 per cent moisture of air.		Breakdown voltage.	
1	0.00729	29,000	megohms.	10,990	direct.
2	0.00847	27,000	"	8,550	alternating.
3	0.00819	18,500	"	8,850	"
4	0.01072	38,700	"	10,800	"
5	0.00934	167,000	"	10,200	"
6	0.00867	103,500	"	9,750	"

Sheets of copper 0.002 in. thick were also treated in a similar manner and tested with regard to their resistance against temperature, and it was found that at about 750° Fahrenheit the coat of varnish was destroyed, while it only began to crack at 480°, and that when bent at a radius of 0.039 inch.

An Odd Arc Lamp.—Fig. 3 illustrates the "Hackl" arc lamp of Ganz & Co., Budapest, which A. Hausegger describes in a recent issue of the "Zeitschrift fuer Elektrotechnik." The mechanism of the lamp is composed of two racks, one for each carbon, inclined at an angle of about 90°; the racks having a series of pinions and a lever system for insuring the regular movement of the carbons. The mechanism is driven by the weight of the carbons and carbon holders, the movement being controlled by the action of a solenoid. By the use of coreless solenoids the lamps burn without noise, and with the exception of the carbon holders and the contacts connecting them with the circuit, none of the outer or inner parts conduct current. Flatly pointed wick-carbons are used in order to insure a steady arc, and also to prevent the arc from rising in consequence of the heat. The lamps require 10 amperes at a pressure of 28 to 30 volts. Fig. 4 gives curves of the intensity and distribution of light from the "Hackl" and the ordinary arc lamp. The heavy line representing the "Hackl" and the light line an ordinary arc lamp; the right and left half of the curve showing the intensity with and without a globe, respectively. The makers claim that the lamp consumes only 0.52 watt per candle-power, while the ordinary arc lamp requires three times that amount. As will be seen from the curve, the lamp gives higher values all round than the ordinary arc lamp, especially below the lamp. The system is, however, not well adapted for any other than alternating currents, since the greater part of the rays would not be projected vertically downward with direct current, but in the direction in which the positive carbon is placed; besides, the positive carbon would also be twice as thick as the negative one, so that besides other disadvantages, heavier shadows would be produced on the side of the positive carbon.

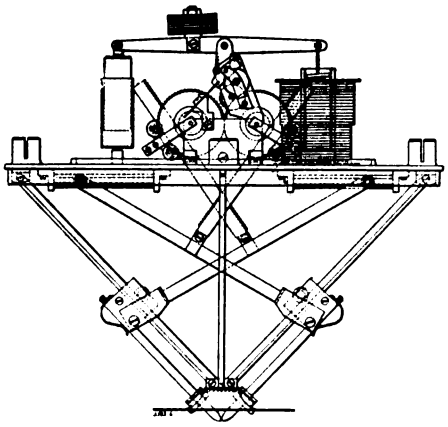


FIG. 3.—"HACKL" ARC LAMP.

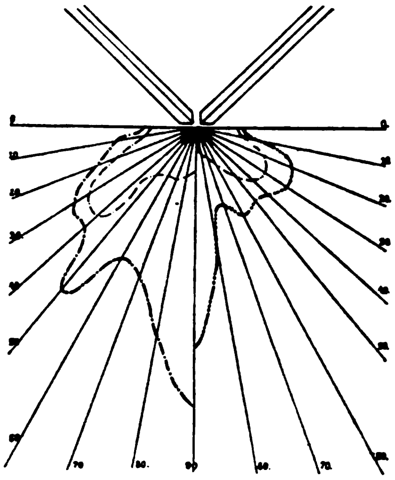
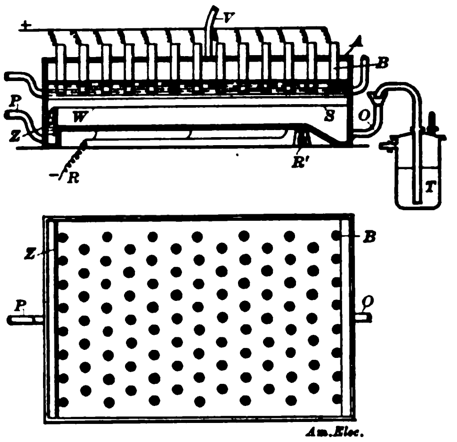


FIG. 4.—CANDLE-POWER CURVES.

Electrolytic Alkali Cell.—A cell closely resembling that described by Ernest Franke in his article on the "Electrolytic Production of Soda and Chlorine" in the March number of this paper, is described in a recent issue of the London "Electrician." The cell, a sectional elevation and plan of which is shown by Figs. 5 and 6, consists of a closed rectangular vessel, *A*, provided at *Z* with an adjustable "bridge" or weir. The bottom of the cell up to the level of this weir is filled with mercury, which at *R* is in electrical contact with the negative terminals of the dynamos. The pipes, *O* and *P*, supply and withdraw the mercury when the cell is at work. The cell is charged with a concentrated solution of sodium or potassium chloride, and into this dip a large number of carbon or platinum anodes. Pipes are provided, as shown, for the circulation of the electrolyte, and an outlet pipe, *V*, is also provided for the escape of the chlorine gas produced. The cell operates as follows: The sodium or potassium liberated at the surface of the cathode combines with the mercury to form an amalgam. This amalgam floats upon the surface, *SW*, and the circulation of the metal in the bottom of the cell carries it toward the weir *Z*, over which it passes. The amalgam is collected at *P*, the sodium or potassium reclaimed and the pure mercury returned to the cell by means of the pressure vessel, *T*, and the supply pipe, *O*. The drift of the amalgam toward *Z* is assisted by the current of brine passing through the cell in the same direction. The cell is in successful operation in Belgium and in Russia in the caustic alkali and bleach plants of Solvay & Company.



FIGS. 5 AND 6.—SOLVAY CELL.

Formation of Boiler Scale.—Calcium sulphate is probably one of the most obstinate substances found in water with which engineers have to contend, when dealing with feed-water and the formation of boiler scale. Not only is its presence so frequent but the stony scale formed by it adheres so tenaciously to the boiler that it is with difficulty removed. In a recent issue of the "Revue de Mecanique" M. Boyer-Guillon reviews what published information is to be had on the subject, and describes the apparatus and methods of experimental observation employed by him. His observations corroborate in a general way the popular notion of diminished solubility with increased temperature; but his experiments show that up to 392° F. complete solubility is not reached. It also appears that the rate of precipitation is somewhat more rapid at high temperatures than at lower; but in every case several hours were required to attain a fixed degree of solubility for a given temperature. It is often attempted to purify feed-water by heating it in a separate vessel before passing it to the boiler; and while the temperature of the exhaust is usually sufficient to throw down the carbonates, the heat of live steam is required for the more or less complete removal of the sulphates. In view of this it is evident that this method of purification permits most of the sulphate of lime to be carried into the boiler with the feed-water, unless sufficient time be given for it to separate, and is therefore only partially effective.

The Influence of Curve Forms on Measuring Instruments.—Dr.Gustav Benischke in a recent issue of the "Elektrotechnische Zeitschrift" shows what influence the different alternating-current curve forms exert upon measuring instruments. Curves *a*, *b* and *c*, Fig. 7, are taken as typical examples of curve forms met with in every-day practice, and the instruments used were induction voltmeters and ammeters, and Kohlrausch's electromagnetic voltmeters and ammeters. Figs. 8 and 9 are plotted values obtained from the induction instruments, and Figs. 10 and 11, values obtained from the electromagnetic instruments. Figs 8 and 9 show that the induction instruments are not affected by the curve form, while the electromagnetic instruments are. On the other hand, he states, it is known that the latter instruments are not affected by the frequency, which is not the case with the induction instruments.

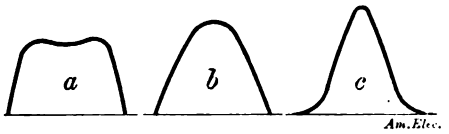


FIG. 7.—CHARACTERISTIC CURVES.

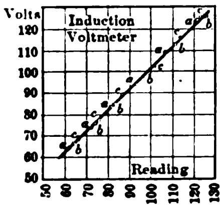


FIG. 8.

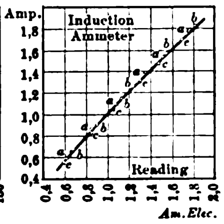


FIG. 9.

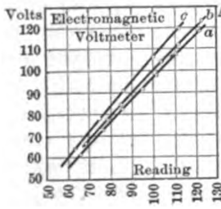


FIG. 10.

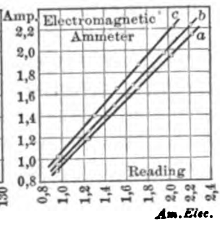


FIG. 11.

Diesel Oil Engine.—An occasion of considerable scientific and industrial importance in Great Britain was the recent exhibition of a 15-h.p. Diesel oil engine built by Scott & Hodgson at Guide Bridge, Manchester, an account of which is contained in "London Engineering." The engine is not only the first of its kind built in England, but the first to be operated on the two-stroke cycle plan, all previous Diesel engines being worked on the four-part cycle system. As is well known, Diesel's invention consists in raising the point of compression far above the limits ordinarily used; and since this could not be done with an explosive mixture in a hot cylinder, he altered the cycle so that instead of drawing in air and oil vapor together and then compressing them, he compresses the air alone to several hundred pounds per square inch and then into this compressed and consequently heated atmosphere he injects oil spray which immediately ignites, the temperature being in the region of 1000° Fahr. The injection takes place when the crank is over the center and the piston begin to travel outward. As will be seen from Fig. 12 no sudden explosion takes place. The oil burns; but not rapidly enough to raise the pressure in the cylinder. When the engine is under full load the top of the indicator diagram is nearly horizontal and shows a distinct cut-off. At this point the pressure begins to fall and drops away in a sweeping curve until the exhaust opens. The air is heated during the burning of the oil at a rate corresponding nearly with the rate of cooling due to the expansion; and after the combustion is concluded the air is expanded down to about 30 lbs. pressure when it is exhausted. The engine that was tested has a power cylinder 7⅞ ins. in diameter, with a stroke of 10¼ ins., and runs at 216 r.p.m. It is horizontal, having in front of the power cylinder and tandem with it, an air pump cylinder 9 ins. in diameter. On one stroke this cylinder draws in air, and compresses it on the other stroke to 4 lbs. per square inch, delivering it into the bed which acts as a reservoir. The discharge valve, however is passed by the piston before the stroke is completed, and the air remaining in the pump cylinder is compressed to 60 lbs. per square inch and delivered to a second stage compressing pump worked by a crank at the end of the crank shaft. This pump has a plunger about 2¾ ins. in diameter, and in it the air is compressed up to 750 lbs. per square inch. On one side of the engine is a secondary shaft driven at half the speed of the crank shaft. This shaft drives the governor by bevel wheels; the governor regulating the quantity of oil injected in accordance with the demands on the engine. The oil is lifted by a pump worked by an eccentric on the secondary shaft; the suction valve of the pump being controlled by a taper piece operated by the governor so as to permit a part of the oil to leak back when full power is not required. The oil is delivered to the inlet valve of the cylinder, and when this valve is raised, the compressed air rushing down through a number of fine grooves drives the oil into the cylinder in the form of spray. The inlet valve, like the exhaust valve, is operated by a cam. The engine is started by means of compressed air, a quantity of which is stored for this purpose in two steel cylinders. Prof. Unwin states that the Diesel engine will convert 37 per cent of the heat in the oil into indicated work and the manufactures of the engine guarantee that the engine of any size will run with .452 lb. of solar oil and crude petroleum per hour per brake horse-power, and that at half load the consumption will not exceed .520 lb. Prof. Meyer, of the Technical High School, Charlottenburg, reports that with raw Tegersee oil of a specific gravity of .789 at 68° Fahr. an engine he tested consumed .467 lb. at normal load, .488 at ¾ load and .567 lb. at ½ load. The engines, it is said, will work with the very cheap tar oils.

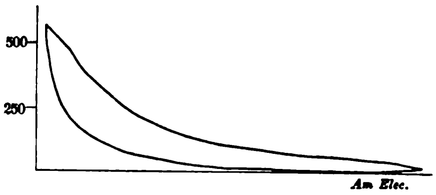


FIG. 12.—INDICATOR DIAGRAM.

Some Recent Electrical Patents

Brush-holder.—One of the disadvantages attendant upon the use of a brush-holder for carbon brushes to which the brush is positively attached is that as the brush wears away and is forced toward the commutator by the holder, the point of contact with the commutator is shifted by reason of the change in the angle between the brush and a line tangent to the commutator. In the brush-holder illustrated by Fig. 1, which has been patented by Wm. D. Pomeroy, this disadvantage is eliminated by a peculiar form of parallel motion. The brush is attached firmly to a holder plate, 12, pivoted to the curved arm, 11; the lower end of the brush-holder plate is attached by means of a flexible laminated conductor, 17, to the arm, 8. To this same arm the curved finger, 11, is pivoted at 10. The two points to which the ends of the laminated conductor, 17, are attached by screws, and the pivots, 10 and 12, of the curved finger, 11, from the corners of a parallelogram, so that the movement of the brush-holding plate is as though it were hung on a pair of parallel links, and the angle between the carbon block and a line tangent to the commutator is maintained unchanged. Pressure is applied in the usual way by means of a spiral spring coiled about the pivot, 10, and having its free end, 16, adjustable in notches along a segment, 15, which is integral with the curved finger, 11. Patent No. 670,059.

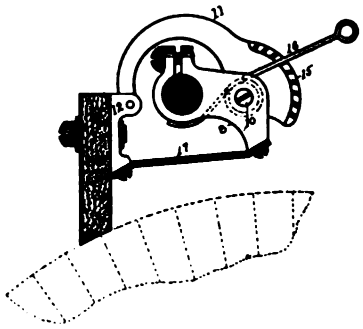


FIG. 1.—BRUSH HOLDER.

Combined Ammeter and Socket Plug.—In order to eliminate the disadvantage of flexible cord connections, Gustav Grabosch has devised an ammeter, the structure of which includes a socket plug for connecting the ammeter to the circuit direct instead of through the medium of flexible cord. Fig. 2 illustrates the arrangement. The ammeter, as illustrated here, is of the magnetic vane type; the exciting coil, *b*, is wound on a bobbin, *a*, having a screw-thread extension, *c*, sheathed with metal, *d*, to which is attached one end of the ammeter coil; the other end of the coil is attached to the tip, *l*. The magnetic vane is mounted in the center of the bobbin, *a*, and the pointer, *h*, and dial are enclosed by a transparent hood, *o*. A spiral spring, *i*, is employed to bring the pointer to zero. Patent No. 670,174.

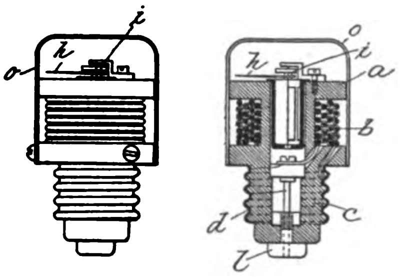


FIG. 2.—AMMETER AND PLUG.

Knife-Blade Switch — In the ordinary knife-blade switch in which the movable blade is forced between two parallel jaws in closing the circuit, a common disadvantage is that if the jaws are set close enough together to give a firm contact, when the blade is forced home the free ends of the jaws are forced apart so far as to put the jaws out of parallel with each other and give insecure contact in the neighborhood of their free ends. Fig. 3 herewith illustrates a form of switch designed by Wm. F. Bossert with a view to obviating this disadvantage. The blade is made duplex so that it embraces the stationary clip instead of being embraced by it. The stationary clip, 32, consists of two thin parallel strips with the upper edges rounded in order to facilitate their entrance between the parallel plates of the knife blade. The knife blades and stationary clips are made of spring material. A vertical cross-section through the clips and blades is shown at the upper left-hand part of the engraving, and a section through the clips alone at the upper central part. Patent No. 670,145.

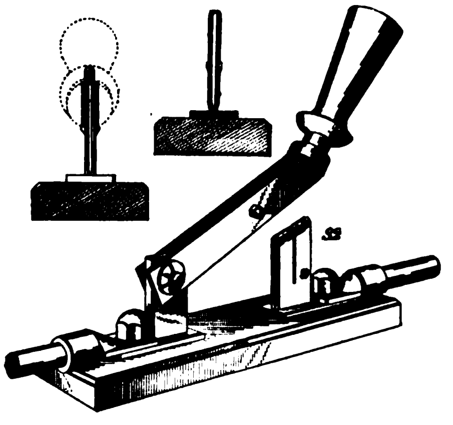


FIG. 3.—KNIFE BLADE SWITCH.

Contact Finger for Motor Controllers.—With the ordinary arrangement of controller contact fingers any change in the adjustment of the finger to compensate for wear is effected by adjusting the tension of the finger; consequently, if the finger springs are at the outset given the proper tension to secure the best operation, subsequent adjustment for wear vitiates the original adjustment and makes the tension either too great or too little. In order to obviate this, Frank W. Garrett provides an auxiliary adjustment, as indicated in Fig. 4 herewith. The usual spring adjustment is provided between the contact finger, *D*, and the end of the arm, *G*, adjustment being made by means of the nuts at *F*. The position of the arm, *G*, however, is adjustable by means of the screw, *H*, which is tapped into the stationary framework of the controller, so that the relation between the tip of the contact finger, *D*, and the controller drum may be adjusted without altering the tension of the spring, *E*. Patent No. 671,079.

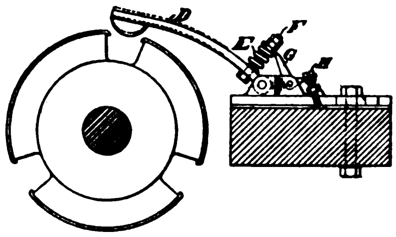


FIG. 4.—CONTACT FINGER.

Anti-Sparking Commutator.—Double-current generators and rotary converters, as generally built, manifest more or less serious sparking at the direct-current commutator because the current in the coils which are undergoing commutation is not uniform throughout a cycle; and the resultant armature reaction also varies, thereby varying the field strength under the pole tips. There is therefore no position at which the direct-current brushes will be sparkless throughout a cycle. The conditions just described require that the brushes should be moved back and forth on the commutator during each cycle, so that the brushes will commutate the current in those coils of the armature which are in position with respect to the field most favorable for commutation. If such a machine were made bipolar, for example, the brushes, during one cycle or complete revolution, would require to have a positive lead, and during other operations a negative lead, corresponding to the generator and motor actions, which alternate in the machine. It is manifestly impracticable to rock the brushes back and forth in accord with the variation in the position of the armature coils with respect to the commutating field and their own reaction; Prof. Elihu Thomson, however, proposes to accomplish the same result by varying the width of the commutator segments, as illustrated by Fig. 5, which shows approximately the gradations that would apply to the commutator of a bipolar machine. In a multipolar machine, of course, what might be termed the "cycles of variation" in commutator width would be increased proportionately to the number of magnet poles. Patent No. 665,486.

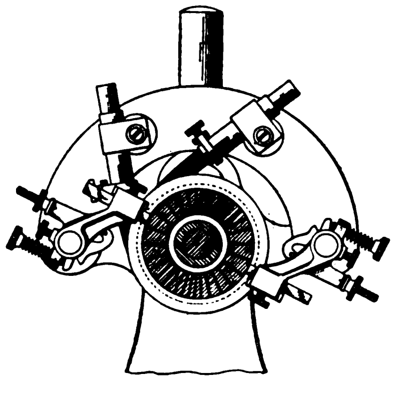


FIG. 5.—ANTI-SPARKING COMMUTATOR.

A Synchronizing System for Alternators.—In coupling alternators in parallel it is customary to bring the fresh alternator into synchronism by regulating the speed of its engine. After the alternator is thrown in, however, it is usually the practice to rely on the engine governor for maintaining the proper speed. With a view to enabling the switchboard operator to control the speed of an engine both at the time of paralleling and after the alternator is in actual operation, H. W. York has devised and patented the electrical controlling system indicated by Fig. 6. A rocker arm, I, is interposed between the eccentric rod and the valve gear, and a sliding block, H, to which the end of the eccentric rod is pivoted, is adapted to be moved back and forth along the rocker arm by means of a screw-threaded rod driven by the motor, M. It is evident that varying the position of the sliding block, H, will vary the throw of the valve and therefore the cut-off. The motor is controlled from the switchboard and pilot lamps are provided which indicate when the block, H, reaches the

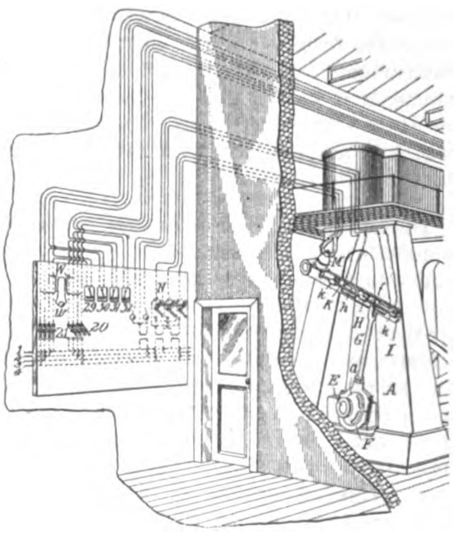


FIG. 6.—ENGINE SPEED CONTROLLER.

extreme end of its travel in either direction. The division of load between the alternators evidently may be controlled by means of this arrangement. This arrangement has been made the subject of three patents, one covering the system, another the apparatus, and a third the method of synchronizing. Patents No. 668,429, 668,430 and 668,431.

Casing for Electric Motors.—The object of the present invention is to provide a casing for electric motors which can be adjusted either to completely enclose the machine or to uncover apertures in the stationary part of the casing and give access to the brushes and commutator. To carry out this object the inventor, Charles A. Eck, provides a rotatable shield exactly similar to the rotating damper of an ordinary stove, and mounted on the end cap of the motor or dynamo concentrically with the bearing. This movable shield is provided with apertures corresponding in shape and size to apertures in the case of the motor, so that it may be turned either to expose the apertures in the stationary part of the machine or to cover them up. Patent No. 669,577.

A Means for Preventing Hunting.—It is frequently the case that an alternator direct-connected to a steam engine, the moving parts of which do not possess sufficient inertia to maintain uniform angular velocity throughout each revolution, has its rate of rotation varied to such an extent during each revolution that the resultant alternating current has a pulsating frequency. Under this condition the operation of synchronous motors or rotary converters from the circuit supplied by such an alternator is usually attended by excessive hunting. Harold W. Buck has found that by varying the field excitation of the synchronous motor or rotary converter, and in time with the engine stroke, the pulsation in the frequency of the alternating-current supply is neutralized and hunting prevented. Fig. 7 represents diagrammatically the apparatus devised and patented by Mr. Buck for this purpose. In the drawing the armature of the synchronous motor is indicated by the figure 8, and the field coils by 9 and 10; the alternating-current supply circuit, 2, 3, 4, is connected to the collector rings in the usual manner, and the field windings are supplied from a direct-current circuit, 11, 12. Connected in series with the field circuit is a resistance, 13, which is periodically varied with relation to the field circuit by means of the reciprocating brush, 17; in shunt with this resistance is a manually-adjustable rheostat, 25. Both of the resistance coils are non-inductive. The reduction of speed in the worm gearing is such that the reciprocating brush, 17, moves to and fro in unison with the rise and fall of crank effort at the engine which drives the generator supplying alternating current to the motor. The variation of the resistance in series with the field winding varies the torque between the field magnet and the armature winding so as to counteract the tendency to hunting. The hand rheostat, 25, is provided for the purpose of adjusting the degree of variation in field strength. The sketch, *B*, in the lower right-hand part of the diagram, illustrates an arrangement of change gearing whereby any desired adjustment may be secured to adapt the machine for circuits having various periods of pulsation in their frequency. The small spur wheel, 26, is driven synchronously with the motor armature and drives the gear, 27, through the medium of an idler, 28. The arm, 30, which carries the small gear and the idler, is adjustable about the center of the gear, 26, in order to allow the gear wheel, 27, to be replaced by another wheel having a different number of teeth, thus varying the reduction of speed between the motor shaft and the eccentric shaft. Patent No. 667,114.

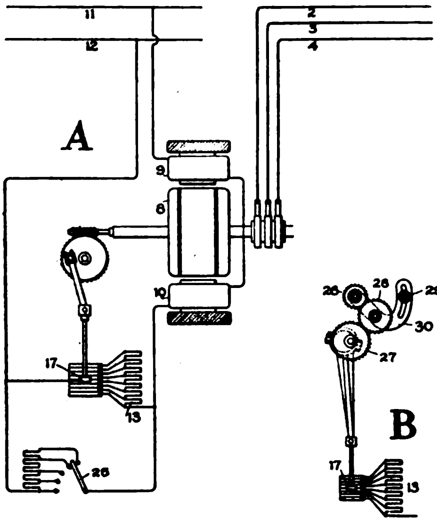


FIG. 7.—DIAGRAM OF CONNECTIONS.

◆

NEW BOOKS.

The Universal Electrical Directory. (J. A. Berly's.) London: H. Alabaster, Gatehouse & Co. Red cloth; 1250 pages, 6 x 9 ins. Price in Great Britain, 7s. 6d.; elsewhere, 8s. 6d.

This, the 1901 edition of the well-known "red book," has been enlarged by 57 pages since last year. The directory is particularly complete and the arrangement of its contents extremely convenient. The American section contains 6160 names and the reviewer has been unable to find a single error in that part of the record which comes within his personal knowledge of names and addresses, which is not of narrow scope.

Electric Lighting. (Vol. II.) By Francis B. Crocker. New York: D. Van Nostrand Company. Cloth; 505 pages, 6 x 9 ins.; 391 illustrations. Price, $3.

This volume of Professor Crocker's work is devoted to all of that portion of an installation outside of the generating plant. This latter part was the subject of the first volume, so that the two volumes cover the entire plant. This volume discusses wiring, systems of distribution, overhead and underground conductors and their installation, arc and incandescent lamps, motor-dynamos, transformers, meters, etc., in a clear and concise manner which is usually explicit enough without being verbose. The book also contains an appendix comprising the National Underwriters' Code for 1901 and another consisting of the report of the Standardization Committee of the American Institute of Electrical Engineers. It is to be hoped that Professor Crocker will be able to keep both volumes up to date by frequent revision, as the subject matter is most valuable and its intrinsic value is enhanced by the style of treatment.

Inventor's Manual. New York: Norman W. Henley & Co. Cloth; 115 pages, 5 x 6½ ins. Price, $1.

This is an interesting little book and one of undoubted value to young inventors. While tending to stimulate inventive ambition, there are no ridiculous statements leading the uninitiated to suppose that the only requisite to untold wealth is the invention of something, no matter what,—anything. The absence of this sort of buncombe raises this book far above the level of those of the more pretentious productions, the chief object of which is to line the pockets of some alleged patent attorney.

Handbook on Engineering. By Henry C. Tulley. St. Louis, Mo.: Henry C. Tulley & Co. Leather, with flap; 792 pages, 4½ x 6½ ins.; fully illustrated. Price, $3.50.

This is a member of the "hand-book" class, and contains a great deal of moderately elementary information concerning steam and electrical apparatus. The principles of dynamos and motors are explained in very clear language and with almost uniform accuracy; the explanation of brush sparking is not quite complete, however, no mention being made of the inductance of the commutated coils. An amount of attention is paid to Brush and T.-H. arc-lighting dynamos which is by no means justified by the present status of these machines with relation to the progress of the art, while very little space is devoted to constant-potential generators and there is not a line concerning alternators or alternating-current apparatus. The steam portion of the book is similarly unbalanced. Considerable space is devoted to Russell, Porter-Allen, Harrisburg, Ideal and Westinghouse engines, with a very moderate amount to the Corliss engine (and this amount devoid of any description of the releasing gear), while the McIntosh & Seymour engine is dismissed with a single page and there is no mention whatever of Allis, Rice & Sargent, Ball and other prominent engines. A considerable amount of space is devoted to refrigerating apparatus, and a practical discussion of the use and management of steam boilers, pumps, injectors, etc., also come in for a good share of discussion, as well as hydraulic elevators and air compressors. The matter contained in the book is excellent, the only criticism one might make being based on the omission of a great deal of matter which logically should have been included.

PROF. HENRY A. ROWLAND.

The scientific world suffered a great loss on April 16 by the death of Prof. Henry A. Rowland, at Baltimore, Md. Professor Rowland was born at Honesdale, Pa., November 27, 1848, and was graduated from the Rensselaer Polytechnic Institute, Troy, N. Y., in 1870, as a civil engineer. The next year found him railroad surveying in Western New York, but his services as a teacher were soon called into requisition at Wooster University. In 1872 he returned to Rensselaer as instructor in physics, and in 1874 he became assistant professor. In the meantime, he had completed his now widely known experiments on magnetic permeability, but at first he was unable to get them published. The scientific journals in America rejected his work, but, confident of its value, he sent his results to Clerk Maxwell, who at once had them published in the "Philosophical Magazine."

When the authorities of the newly founded Johns Hopkins University, at Baltimore, sought for some one to fill the chair of physics and become director of the physical laboratory, Professor Rowland, with his already recognized ability, and with the countenance which Maxwell's recognition of his talents gave, was chosen for the place. This was a year before the University actually opened and he spent the year in Berlin, working with Helmholtz. Here he investigated the effect of static electricity in motion, and later offered the first proof of Maxwell's hypothesis of the identity of electromagnetic and luminous undulatory transmission by demonstrating that a static charge moving with the velocity of light has the effect of a current. Later on, in accordance with an international agreement, Professor Rowland was selected by the United States Government to determine the absolute value of the ohm.

THE LATE PROF. HENRY A. ROWLAND.

While the energies of Professor Rowland were largely devoted to exhaustive researches into the nature and phenomena of electricity and magnetism, his work took a broad sweep through pretty well the whole range of physics. He devised a very exact method for determining the mechanical equivalent of heat, and the value of 778 foot-pounds obtained by him replaced that of Joule (772), which had hitherto been accepted by science. To the public his name is probably even more familiar in connection with his large diffraction gratings, which are ruled by a method of his own directly on concave mirrors, the image of the solar spectrum being thus produced without the aid of lenses. In fact, the photographs of the spectrum obtained with the aid of these gratings far exceed anything else of the kind, and their exhibition before the National Academy of Sciences in 1883 was one of the leading scientific events of the year.

The degree of Ph.D. was conferred upon Professor Rowland by Johns Hopkins University in 1880. As a member of the Electrical Congress at Paris in 1881, and of the jury at the Electrical Exhibition at the same time and place, he received the order of a Chevalier of the Legion of Honor. In 1881 he was elected a member of the National Academy of Sciences. In 1883 he presided over the Physics Section of the American Association for the Advancement of Science, at Minneapolis, and read a memorable address, entitled "A Plea for Pure Science." In 1884, being appointed by the Government on the commission specially formed for the purpose, he presided over the deliberations of the National Conference of Electricians at Philadelphia, and delivered an address. During the same year he received from the American Academy, of which he was an associate, the Rumford medal for his researches in light and heat, and since then other well-merited honors have been bestowed upon him. In 1893 he was elected presiding officer of the International Electrical Congress, sitting at Chicago. During the past eight years Professor Rowland devoted much time to the perfection of a system of rapid telegraphy, a working exhibit of which formed, perhaps, the most interesting feature of the American electrical section of the recent Paris Exposition.

Professor Rowland was the author of many papers of great importance, most of which relate to his far-reaching researches into various scientific subjects. In addition to developing the resources of the physical and electrical laboratories at Johns Hopkins, where, in addition, an electrical testing bureau was established by him, he managed to devote considerable time to many other matters of importance.

NOTES.

A Recipe for Bronze Varnish.—The *Metallarbeiter* gives the following formula for a bronze varnish: Equal parts of good linseed oil varnish and copal or amber varnish, into which is stirred sufficient fine bronze (about 12 ounces of bronze to one pound of varnish) to give a permanent gloss and coloring. A thin application of the varnish is essential for a handsome appearance. The coating has to be baked after being applied.

A Marvelous Process.—According to a contemporary which classifies itself by its own name as a journal of science, a process for treating window panes is used in Germany which consists of painting the panes on one side with a liquid prepared by grinding whiting in a potash waterglass solution. After one or two applications, it is stated the panes are *perfectly opaque*, while the room remains as light as before!

A Substitute for Coal.—According to a press despatch, a workman in a German chemical works has devised a substitute for coal, of which peat is the basis. The fuel is said to cost about $2.50 per ton, and to give out "a great heat." The despatch also states that the fuel "burns with a bright flame and leaves no slag," but it does not state what the calorific value per pound is. The peat is dried, ground up and mixed with chemicals, and the compound is pressed into brick shape.

Dynamo and Motor Discs and Castings.—Those of our readers who have been interested in the descriptions of small motors and dynamos which have been published from time to time in this paper will doubtless be glad to learn that magnet castings and armature core discs for the direct-current machines are obtainable from the American Motor Construction Company, Sip and Olean Avenues, Jersey City, N. J.

The Switchboard Instruments in the Swift Plant.—In the description of the power plant of Swift & Co., which appeared in the April number of this paper, the statement was made on page 152 that "all the switchboard instruments are of General Electric manufacture." This statement, we are informed, is incorrect, the left-hand half of the switchboard, consisting of the arc lighting and incandescent lighting panels, having been entirely equipped by the Wagner Electric Manufacturing Company, St. Louis, Mo.

A Direct-Connected Gas Engine Outfit. —The San Francisco Gas & Electric Company is installing a 200-kw. General Electric dynamo direct-connected to a 300-h.p. gas engine built by the Union Gas Engine Works, of San Francisco. The engine is a four-cylinder machine, and the cranks are set 90 degrees apart, so that the crank shaft receives an impulse twice in each revolution, exactly as in the case of a single-cylinder steam engine. The speed of the shaft is 200 r.p.m. The engine will be supplied with producer gas made on the premises.

Electric Light Consolidation in Maine. —The Sebago Power Company, the Cumberland Illuminating Company, the Deering Electric Light Company, and the Portland Electric Light Company, all of Portland, Me., have consolidated under the Cumberland Illuminating Company's charter, with the corporate name of the Portland Lighting & Power Company. The company is capitalized at $350,000, $100,000 of which is preferred stock and $250,000 common. The officers of the new company are: J. R. Libby, president; M. H. Kelly, vice-president, and E. H. Mather, treasurer and manager.

Electric Traction in France.—Some recently published statistics on electric railways and railroads in France afford interesting reading as an index of the growth of electric traction in Europe. In 1890 the first electric railway was installed in France at Clermont-Ferrand. Since then electric traction in France has developed with wonderful rapidity. The total length of lines in use has nearly doubled during the last year, being 1486.3 kilometers at the beginning of this year against 752.3 a year previous. The total power of the central stations has been tripled in 12 months; the output having increased from 28,308 kilowatts last year to 64,383 kilowatts this year.

The Utilitarian "Chinee."—A new and curious application of electricity, which, however, is not to be taken very seriously, is related by the "Journal d'Electricité." G. A. Wiese who has recently returned from China where he had gone to install an electric light plant in the town of Canton, gives among other interesting items, the following, which takes first place in point of originality. Many of the streets of Canton are so narrow that it was impossible to set poles for the support of the overhead wires; consequently it was necessary to obtain permission from the town authorities to fix supports to the walls of the houses. After the wires were put up an inspection of the line was commenced. The astonishment of the inspectors may well be imagined when they saw the lines liberally garnished with linen which the townspeople had put out to dry. The wires were "alive" with alternating current at 1000 volts, and it is surprising that nobody was killed. When the Chinese had been warned of the danger they smiled in the historic "childlike and bland" manner of Bret Harte, and said that electricity dried their linen better and quicker than the sun, and refused to take in their belongings. Mr. Weise was obliged to resort to the local authorities to put a stop to this novel utilization of the wires.

Telephone Consolidation. —The United Telegraph & Telephone Company, with headquarters in Baltimore, has acquired the Maryland Telephone & Telegraph Company, the Pittsburgh & Allegheny Telephone Company, the West Pennsylvania Long Distance Telephone Company, the Home Telephone & Electric Company, the Allegheny County Telephone Company, and the Harsford County Telephone Company. The aggregate capital stock of these companies is $3,910,000. The West Pennsylvania Long Distance Telephone Company owns a line from Pittsburgh to Beaver, Pa., where connection is made with the United States Long Distance Telephone Company that gives service to Cleveland and other Ohio towns. According to a press despatch, more than 167,000 telephones will be connected by this line with the Pittsburgh and Allegheny plant.

Italian Steam Road to be Changed Over. —The Italian Mediterranean Railway Company has for some time past been studying a project for the adoption of electric traction on its line between Milan and Gallarate, including branches in three directions toward Lakes Majjori, Varese and Lugano, to the towns of Arona, Laveno and Porto-Ceresio. The length of the line from Milan is 25 miles and the three branches are 16, 20 and 21 miles long, respectively. The third-rail system is contemplated. Primary three-phase currents at 12,000 volts would be conducted to the sub-stations and converted by means of transformers and rotary converters to continuous current at 650 volts. The power station would be situated near Tornavento, a fall on the Tessin River being utilized for the development of motive power. Eight large turbines would be installed for the alternators and two small ones for the exciters. According to present specifications the power of each hydraulic unit will be 1,120 horse-power and that of the alternators will be 742 kilowatts each. The line to the sub-station at Gallarate is to be six wires of 7.8 millimeters diameter each, hung on porcelain insulators, on poles. There will be five sub-stations between Milan and Porto-Cenesio. The rolling stock will comprise 20 motor cars and 20 trailers; the former capable of carrying 75 passengers and the latter 93. Each motor car will be equipped with four motors of 75 horse-power and lighted by 20 incandescent lamps.

Laying Cables for the New East River Bridge —On April 7 the first important step was taken in the making and laying of the cables for the New East River Bridge between New York and Brooklyn. The preparation of plans and other preliminary work, as well as the main part of the contract which is to follow, is under the supervision of Mr. Charles G. Roebling, president of the John A. Roebling's Sons Company, who is assisted by Mr. William Hildenbrand. The work done last month was the placing in position of the 2¼-in. diameter ropes which support the temporary foot bridge on which the workmen will stand during the main work of cable laying. Several methods of getting the first line of a bridge across have been employed in the past, and kites, swimmers and other means have been tried, but the method employed on this occasion has, we believe, never been tried before, and appears to be a distinct advance over all previous ones. The drum containing the cable was carried across the river on a float (one end having previously been secured) and the cable was paid out and allowed to rest on the river bed until such time as it could be raised from the water and to the desired height by means of a stationary engine and drum. The first cable was successfully raised on April 11, the time required being only seven minutes, navigation being, of course, suspended during that period.

The Water Power Plant of St. Gall.—The central power station that was installed at the end of last year at Kubel, Switzerland, for the supply of electric light to 14 communes of the cantons of St. Gall and Appenzell, is now in full working order. The station, which is situated about three miles from St. Gall near the Appenzell frontier, is one of the largest in east Switzerland. The plant receives its motive power from the Urnäsch River, which although small, supplies periodically an immense volume of water owing to the frequent heavy rains. To collect this periodic flow a reservoir has been constructed. It is intended, however, with a view to securing a more assured reserve, to utilize also the waters of the Sitter River. A dam has been constructed in concrete which leads the waters of the Urnäsch River into a tunnel bored through rock. This tunnel is 4.6 meters (15 ft.) long, 1.9 meters (6¼ ft.) wide and 2 meters (6 ft. 6¾ ins.) high, and has a declivity of 7½ in 100. It terminates in an artificial lake called the "Gübsenée," created as the reservoir mentioned above. This was formerly the site of a small marshy valley, and has an area of 42 acres; it has a capacity of 1,500,000 cubic meters (52,970,000 cu. ft., or 396,257,000 gallons) of water. The power station is situated on the right bank of the Sitter River. It contains four turbines of 500 horse-power each, and two others of 750 and 1000 horse-power respectively will be installed as soon as the arrangement for drawing from the Sitter is completed.

ESTABLISHED 1889.

American Electrician,

WITH WHICH IS INCORPORATED
Electrical Industries.

CECIL P. POOLE, Editor.
W. H. ONKEN, Jr., Associate Editor.

Published on the first of each month by the

American Electrician Company,

NEW YORK: 120 Liberty Street.
CHICAGO: Monadnock Block.
PHILADELPHIA: 929 Chestnut Street.

JAMES H. MCGRAW, President.
A. E. CLIFFORD, Vice-President.
C. E. WHITTLESEY, Treasurer.
E. E. WOOD, Secretary.

Subscription, - $1.00 Per Year.

In the United States, Canada and Mexico.
FOREIGN COUNTRIES, $2.00.

NOTICE TO ADVERTISERS.

Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

IMPORTANT NOTICE.

Intending subscribers are warned not to place subscription orders with persons who cannot show written authority to take such subscriptions and make collections therefor, as the paper will not undertake to fill orders placed with alleged agents acting without such written authority.

Subscribers requesting a change of address should invariably furnish both the old and the new address.

Vol. XIII. MAY, 1901. No. 5

The American Electrician has a larger paid subscription list than any other electrical journal in the world.

CONTENTS.

A Combined Electric Lighting and Steam Heating Plant, by W. N. Zurfluh....... 201
Pole Setting on the New Orleans Drainage Commission Lines.................... 208
A Simple Method of Locating a Short-Circuit Between Electrical Conductors, by Arthur R. Roe.................... 208
Windings for Electromagnets and Solenoids 209
Electrically-Controlled Bulkhead Doors, by Geo. E. Walsh.................... 213
A. French Corliss-Type Steam Engine.... 214
Economy in Steam Production, by C. W. Obert 217
Abstracts from Foreign Contemporaries.. 219
Some Recent Electrical Patents........... 221
New Books 223
Prof. Henry A. Rowland.................... 224
Notes 224
Editorial 226
The Construction of an Electrodynamometer, by S. M. Kintner.................... 228
Common Battery Telephone Systems, by W. S. Henry 229
Corliss Valve Gear and Valve Setting, by C. C. Major.................... 230
Railway Car Notes, by A. B. Weeks...... 233
The Sprague Multiple-Unit System, by Edward Chilton 234
Disposing of the Water of Condensation, by C. W. Obert.................... 235
Direct-Current Dynamos in Parallel, by Alton D. Adams.................... 237
Lessons in Practical Electricity............ 238
Letters on Practical Subjects............... 239
Electrical Catechism 241
Queries and Answers.................... 242
A Quick-Closing Water Gauge.............. 243
S. K. C. Frequency Changer............... 243
Shunts and Transformers for Electric Measuring Instruments 244
New Apparatus and Appliances............ 245
Legal Notes ....Adv. 37
Obituary ....Adv. 37
Personal ....Adv. 37
Trade Publications ....Adv. 37
Business News ....Adv. 38

Absolute Temperature.

The steam engineer with an ambitious disposition and a studious turn of mind will meet with constant reference to "absolute" temperature in writings relating to heat efficiency, work done by the expansion of steam, etc., and may be somewhat puzzled by the distinction between ordinary and "absolute" temperatures. This may be explained with sufficient accuracy for practical purposes as follows: The two standards of temperature are the freezing point and the boiling point of unconfined water; on the Centigrade scale these are arbitrarily, but rather logically, taken as 0 and 100 degrees, respectively, the scale being simply divided into 100 equal parts between the two standard points. Having thus established a scale, it was a simple matter to extend it in both directions. The Fahrenheit scale is entirely illogical, the starting or zero point being located an arbitrary distance below freezing.

That neither of these scales is literally correct is evident from the meaning of the word zero; zero temperature would obviously be the point at which there would be no heat, and consequently the point below which there could be no further reduction of temperature. And as temperatures below all of the thermometer zero points are of common record, none of these thermometer zeros can be the actual zero of temperature. This point is the one which is meant by the expression "absolute zero;" and "absolute temperature" is the temperature reckoned from absolute zero.

A perfect gas would be one which had no limit to its elasticity, and as the volume of any gas increases and decreases as its temperature increases and decreases, extracting all of the heat from a perfect gas would cause it to shrink to nothing. Now it has been calculated that a perfect gas taken at the melting point of ice would increase and decrease its volume $\frac{1}{492.66}$ for each Fahrenheit degree of temperature increase or decrease. Consequently, decreasing its temperature by 492.66 Fahrenheit degrees, from the melting point of ice, would reduce the volume to nothing; the absolute zero of temperature, therefore, is considered to be 492.66 Fahrenheit degrees below the melting point of ice (32° Fahr.), or 460.66° below Fahrenheit's zero. It follows that the absolute temperature of any substance is 460.66 more than the temperature indicated by a Fahrenheit thermometer. If we use the Centigrade scale, the absolute or true temperature is 273.7° higher than the thermometer shows. In practical computations absolute temperatures are frequently taken as being 461 higher than Fahrenheit temperatures and 274 higher than Centigrade temperatures.

Boiler Room Practice.

The very name "boiler room" is instinctively regarded by all who are in the remotest degree familiar with this part of a steam plant as being synonymous with grime, dinginess and general disreputability, and the place itself is considered as an inevitable eyesore, to be shunned except under stress of dire necessity. As pointed out in an article on economical steam production, which appears elsewhere in this number, not only does this condition of affairs lack valid excuse for existence, but it is a deliberate waste of money to permit it. Of course, coal is not quite so clean as some other commodities one could mention, and no one expects a fireman to maintain a white duck standard of cleanliness; but between this standard and the filthy condition which generally prevails there is a long stretch of intermediate grades of more or less decency and economy. Moreover, coal is not the only factor in steam production; a greater weight of water than of coal has to be handled, and the judicious application of some of it to windows, walls and facings would metamorphose most boiler rooms. Combined with this cleansing should be provided ample light, so that instead of blinking and feeling his way around in murky gloom between or behind batteries of boilers, the fireman can proceed directly to any point or fitting and work conveniently and rapidly anywhere in the boiler house.

It is by no means contended that clean windows and walls and well-lighted corners will directly improve the steaming quality of the boilers. But the application of a small degree of common sense will show that these conditions deprive a lazy fireman of all excuse for neglect and enable a conscientious one to make the best possible showing. Moreover, clean and light surroundings conduce to a better standard of work generally. This point was forcibly exemplified a few months ago at one of the largest stations in America, where mechanical stokers fed through chutes from an overhead bin are used, and not a pound of coal is shoveled. Upon calling a fireman's attention to the fact that all of the fittings were covered with grime, and asking if they were ever cleaned off, we received the following courteous answer, delivered in a surly tone: "What th' ——'s the use in this —— ——. dungeon."

Synchronizing Alternating-Current Machines.

The importance of careful synchronizing in coupling alternators and rotary converters, as differentiated from the haphazard method of throwing tne switch in almost anywhere and depending upon the machines to pull themselves together, can scarcely be overestimated. Notwithstanding that the synchronizing voltmeter is gradually taking the place of the incandescent lamp as an indicator of synchronism, prevailing methods still leave much to be desired, since successful synchronizing depends almost entirely upon the skill of the operator. A nervous or unskilled attendant may, by being a second or so late, cause no little amount of damage, especially after a breakdown when the machines that are running are heavily overloaded and a fresh machine is being thrown in to relieve them. Under such circumstances synchronizing by present methods becomes a difficult operation, because the abnormal load on the engines already running impairs their regulation and the indications of the voltmeter or lamps are so erratic that a "flying shot" is often necessary. This is a risky operation, but the only one possible in such an emergency. Under the conditions cited it is also not uncommon for the voltage to drop so low as to throw out the synchronizing voltmeter entirely, unless it be designed to read accurately for low voltage, and then recourse must be had to synchronizing lamps, which is unsatisfactory because with low voltage the lamps seldom show more than a dull glow. For this reason many stations are provided with a low reading voltmeter in conjunction with the regular instrument. It is, of course, possible to use a voltmeter having a wide range, but such instruments are not so dead beat or so generally satisfactory as those designed to read only over a limited portion of the scale.

Inherent drawbacks in synchronizing by means of lamps are the lag of the light behind the voltage and the uncertainty as to when the lamp reaches its maximum brightness, or if connected up the other way, the lack of indication of perfect synchronism. This latter defect makes it impossible to guard against "short phases." Moreover, a minute or two of flickering light affects the eye so that it cannot readily detect the difference of intensity due to a difference of four or five volts. Switching in on "short phases" is to be avoided, since at best it results in a wrench, and unless the machines are designed to pull in it may easily cause more or less damage. The fault of lagging is not alone confined to the lamps; voltmeters possess it in varying degree. The lag in the voltmeter is of course occasioned by the inertia of the moving parts and also by the damping arrangement. This is manifested in the kick caused by a "quick phase," which results in the momentary indication of a much higher voltage than exists across the terminals of the voltmeter. With a "slow phase" no kick is noticeable and allowance must be made only for the lag of the instrument, which is, of course, a variable quantity depending on the rapidity of the phase.

A strong element of uncertainty is also present in what are commonly known as "standing phases." If the needle slowly drops a volt or two and then comes up again, the switch may be thrown in with safety; but when the needle stands still with perhaps a little quiver, it is risky, as the "phase" may be going back but not be immediately indicated owing to the inertia of the moving parts. Throwing in the switch too late is always worse than throwing it in too early. In the latter case the mechanical action between the machines acts in the same direction as the engine which is bringing them into phase; but in a late "shot" the action is opposed to that of the engine, the motoring current of the fresh machine tending to pull it back into step while the engine is doing its best to pull it farther out of step.

It would seem that the difficulties referred to above might readily be disposed of by means of some form of automatic switching device which would entirely eliminate the personal factor. A differential relay with the two windings supplied from the synchronizing transformers could doubtless be adapted to cause the closure of an electromagnetic switch at the proper moment, reducing the work of an attendant to the mere preparation of the switch and plugging in of the phasing or synchronizing relay. It is true that the inertia of the moving parts of both the relay and the switch might complicate the matter somewhat, but the elements of uncertainty and danger thus introduced would be insignificant in comparison with those inherent in the present rather clumsy methods.

The Rating and Speed of Dynamos and Motors.

The fact that a machine of a given size has one rating and speed as a dynamo and a totally different rating and speed as a motor always appears to the average student to be inconsistent. The explanation is simple enough. The discrepancy in both rating and speed is due principally to the fact that a given machine is operated at a higher voltage as a dynamo than when it runs as a motor. As the speed is almost exactly proportional to the voltage, it will be lower for the motor than for the dynamo; and as the output is directly proportional to the speed, lowering the latter reduces the former. The current-carrying capacity of the machine is practically fixed, regardless of its armature speed; therefore the loss in output due to lower voltage (or the resultant lower speed) when a dynamo runs as a motor cannot be compensated by increasing the current passed through its windings.

For example, a 10-k.w. 125-volt dynamo will have a current capacity of 80 amperes, plus the shunt field current, say 83 amperes total. Assume that its speed is 1300 r.p.m. and its armature resistance 0.06 ohm; the drop in the armature will be $0.06 \times 83 = 4.98$ volts, so that the total e.m.f. generated will be 130 volts, or 0.1 volt per r.p.m. Now if the same machine be put out on the circuit as a motor, under an impressed e.m.f. of, say, 115 volts, the field strength will be about the same as before, as there is no rheostat in the field circuit, and when running at full load the drop of practically 5 volts in the armature leaves only 110 volts of the impressed e.m.f. to be balanced by counter e.m.f.; the speed therefore will be 1100 r.p.m. instead of 1300. The machine will receive from the line 86 amperes (3 in the shunt field winding and 83 in the armature) at 115 volts, or 9.89 kilowatts, and if it has 88 per cent efficiency, it will deliver the mechanical equivalent of 8.7 kilowatts at the pulley. Its ability as a motor therefore would be a trifle over 11 2/3 horse-power. This rough example shows why the speed of a machine is always lower as a motor than as a dynamo, when operated on a given circuit, and why its power-delivering ability is also less when operated as a motor than when it works as a dynamo.

THE CONSTRUCTION OF AN ELECTRODYNAMOMETER.

BY S. M. KINTNER.

One of the best ways to learn about a piece of apparatus is to attempt to build it. This is particularly true of student work where the student has not been doing experimental work for a sufficient length of time to have acquired the habit of examining carefully the instruments with which he works. With this idea in mind it has been the custom at the Western University of Pennsylvania to have students design and build pieces of apparatus which would not only be a great help to themselves, but would supply the laboratory with a set of permanent instruments that could be used in the earlier and rougher work of the student's course, thus saving a great amount of rough usage of the better class of instruments.

It is my experience that students are much more careful in handling the better class of instruments after they have had the practical experience of adjusting instruments of their own make. It shows them the necessity of delicate mountings for accurate work and also the readiness with which such instruments get out of adjustment.

The instruments built this year are electrodynamometers, all of the same general design, but intended for different ranges of current. Ease of construction and repair, as well as sensibility, were points upon which special stress was laid. The accompanying sketches will illustrate how well the first two points were carried out and a test of the instrument given below will show the sensibility. The main frame *F*, and the base, *B*, were made of maple fastened together by glueing and in addition having large screws run up through the base into the uprights, *F*. This gives a very rigid construction. The cross piece, *O*, has a mercury cup for the end, *K*, of the movable coil, *M*. This cross piece, the two clamping strips, *D*, and the core, *E*, complete the list of wooden parts. The other terminal of the movable coil, *M*, dips into a mercury cup in the base of the instrument, at *R*. Each of the mercury cups is made by boring a hole halfway through the wood. These holes are connected by wires to the terminals *T*, *T*. The fixed coil, *I*, is held in place on its core, *E*, by two wooden pieces bolted against the sides of the core, *E*; the desired number of turns being wound in between the clamp pieces. After winding, the coil is boiled in paraffine wax and allowed to cool in it; afterward the wax is cut away with a knife, leaving the coil in its permanent form. As a precaution, thread is usually wound around the coil through holes bored in the core, *E*, in order to insure the coil against unwinding should it become too hot. The terminals of the fixed coil are connected to two binding posts on the other side of the instrument, in a similar position to those shown in Fig. 1; one of these shows in Fig. 2.

The movable coil is made by cutting out a block of wood of the required form and then winding on that the desired number of turns. This coil is readily held in shape by shellac varnish; after the first layer of varnish dries a thread is wound around the coil in the form of a lacing, then another coat of varnish is applied. The top of this coil is clamped by two pieces of hard rubber with a notch cut out to fit the coil. This hard rubber also holds a brass piece which is bent to the shape of a letter U on its side. The brass is attached to the rubber at the point, *V*, by small brass screws which also hold the two pieces of hard rubber together. On the upper side of the U-shaped brass piece, back of the pointer, *P*, is a small piece of 3/16-in. brass rod soldered to the U and having a small hole just large enough to take a small sewing needle, shown at *N*. This small brass rod has a screw secured to its side to which is attached the lower end of the torsion spring. The upper end of the spring is fastened by a small screw tapped into the lower end of the torsion head, *H*. The needle, *N*, is the bearing point and it fits into a small hardened steel hollow cone, *C*, the cone being supported by the brass piece shown. The milled head torsion screw, *H*, is turned from a piece of 1-in. brass rod and has a section in the lower part of ⅝ inch that carries two collars and is of sufficient length in addition to pass through the dial plate, *Z*. One of the collars, *W* (Fig. 1), is simply to clamp the torsion head in place. A leather washer is placed between the collar and the dial plate, *Z*, to increase the friction and at the same time give a certain amount of elasticity to the movement.

The upper collar carries the torsion head pointer, *J*, and is clamped to the torsion head in any desired position by the screw, *A*. A small brass screw with its head cut off, as shown at *G*, makes a good zero stop. Two other small screws at *Y* keep the pointer, *P*, which is attached to the movable coil, from shifting too far.

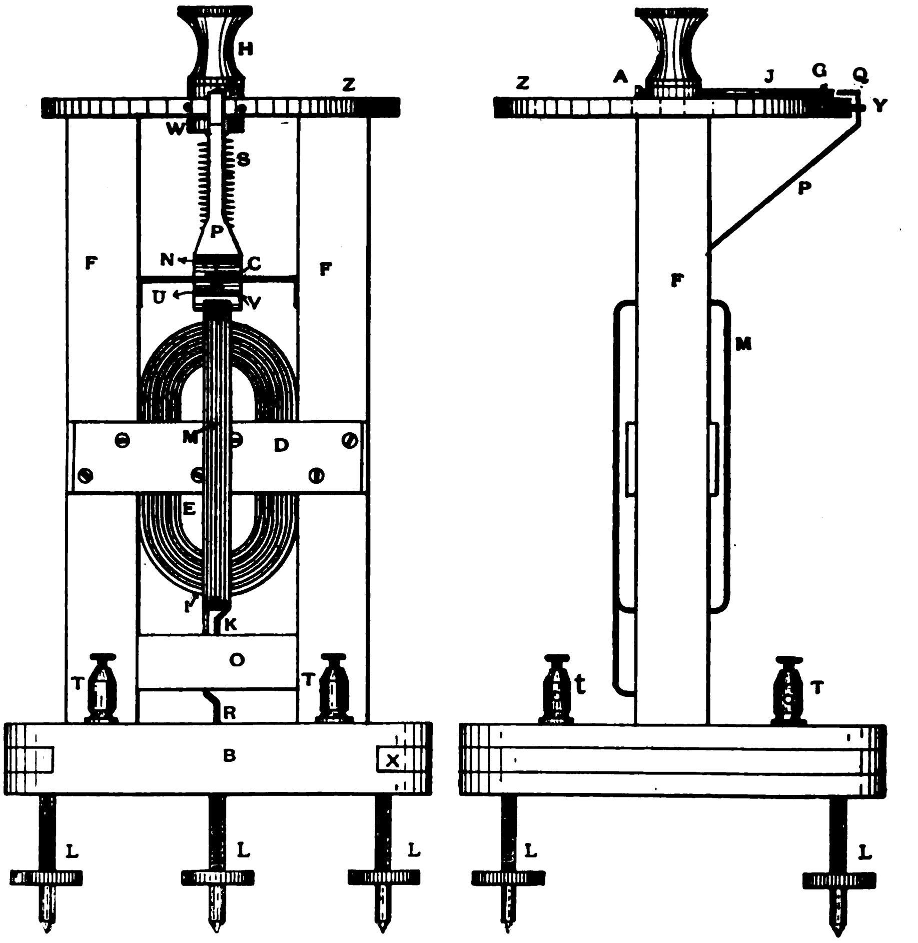


FIG. 1.—FRONT AND SIDE ELEVATIONS OF ELECTRODYNAMOMETER.—FIG. 2.

The dial, *Z*, is made of hard rubber and divided on a milling machine into 360 equal divisions. This hard rubber disc is held in place by two screws passing down through it into the two uprights, *F*, *F*. Three leveling screws, *L*, *L*, *L*, at the bottom complete the instrument. These screws are made by taking ¼-in. brass rod and cutting a cone on one end and a thread on the other. Brass discs are then cut out and soldered on the rods, after which the screws are finished in a lathe.

After assembling the instrument and adjusting all parts until everything looks all right, it is necessary to test for the zero position of the movable coil. The two coils must be at right angles to each other. In order to determine when they are accurately at right angles the following test must be made. The movable coil is short-circuited and an alternating current sent through the fixed coil. As the movable coil will tend to arrange itself in the position of least work, it will tend to turn until its plane is parallel with the lines of magnetism produced by the fixed coil, so that it will enclose no lines of force. This position will be at right angles to the fixed coil and the motion of the movable coil as it attempts to adjust itself will indicate the direction that the torsion head must be turned to bring the coil to the desired position. After a few trials this zero position can be located and the pointer of the movable coil is then fixed so that it indicates zero when the pointer of the torsion head also indicates zero, the instrument being previously leveled.

The following table shows the result of a determination of the constant of the instrument. The comparison was made with a Weston direct-current ammeter having a range of 15 amperes.

Current in amperes.	Deflection, degrees.	Constant of dynamometer.	Difference between const. and average constant.	Per cent variation of constant from average.
1.25	17	.30316	−.00007	.000231
2	43.5	.30350	+.00027	.000890
3	98	.30307	−.00016	.000527
4	174	.30325	+.00002	.000066
5	270	.30430	+.00107	.003529
5.7	356	.30210	−.00113	.003726
Average.........		.30323		.001494

The above values show a close agreement for the constant. The fourth column shows the difference between the average constant and the constant calculated from that particular reading. The fifth column shows the percentage of variation of the constant from the average. The average percentage of variation is a trifle more than 1/7 of one per cent and the maximum variation is less than 2/5 of one per cent. At the time of this test the instrument had been in regular use for over a month and it was tested for the above values without any polishing up of the needle point. This instrument was built for a total cost to the laboratory of less than $1.

COMMON BATTERY TELEPHONE SYSTEMS.

BY W. S. HENRY.

The previous article described the connections of some of the prominent "independent" systems; the present article deals with the system used by the Bell Company. Fig 10 shows the arrangement employed by the Bell Company in its recent common battery systems. The bell, E, should be of high resistance and impedance. It is usually wound to have a resistance of 1000 ohms and the condenser, C, has a capacity of about two microfarads. Enough of the switchboard connections are drawn in this figure to show how the subscriber can call up the switchboard operator and also how the operator can call up the subscriber. When the receiver is on the hook, the contacts, *m* and *n*, are open, and the only path for a current from the battery, B, is through the relay, the sleeve spring of the jack, line 1, the bell, E, the condenser, C, line 2 and the tip spring of the jack. No steady current can flow from the battery, B, through the circuit that has just been traced on account of the condenser, C. However, if the receiver is removed from the hook, enough current can flow from the battery through the relay, line 1, the induction coil primary, the contact, *m*, the hook switch, H; transmitter, T, and line 2, back to the battery to operate the relay. This causes the relay to close a local circuit containing the signal lamp. The lighting up of the lamp notifies the operator that the subscriber desires attention. Hence all the subscriber has to do to call up the switchboard operator is to remove the receiver from the hook, and when the operator answers, to give the number of the other subscriber with whom communication is desired. An annunciator could be used in place of the lamp if desirable. This arrangement of a relay and signal lamp in a local circuit assures the proper operation of the signal so long as the line and subscriber's telephone, when the receiver is removed from the hook, do not offer so high a resistance as to prevent the relay from attracting its armature and so closing the local circuit containing the signal lamps.

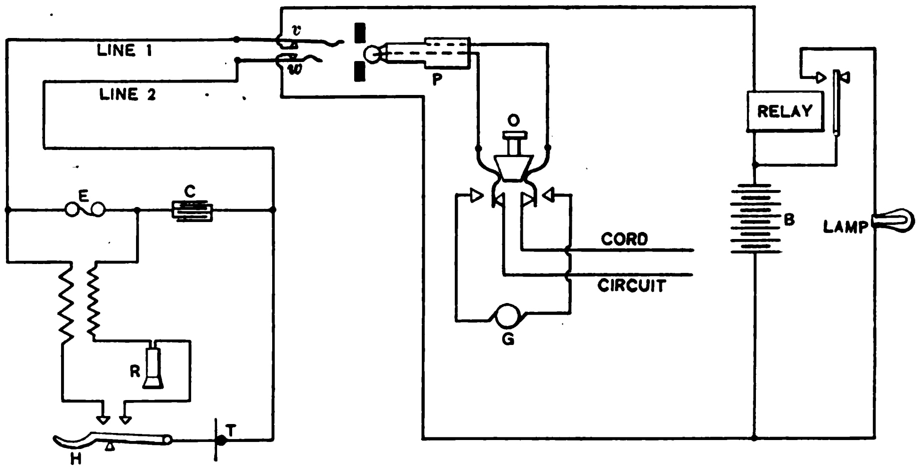


FIG. 10.—COMMON BATTERY SYSTEM OF THE BELL COMPANY.

Suppose that the receiver is hanging on the hook and the operator desires to ring up the subscriber. The operator will insert the calling plug, P, in the jack, thereby lifting the sleeve and tip springs from the contacts, *v* and *w*, and so cutting out the relay circuit. Then by depressing the ringing key, O, the alternating-current generator, G, is connected across the two line wires. This alternating current can flow through the condenser, C, and hence it causes the bell, E, to ring. The path of this current may be traced from G through the sleeve of the plug, P, line 1, bell, E, condenser, C, line 2, the tip of the plug, P, and back to the generator, G.

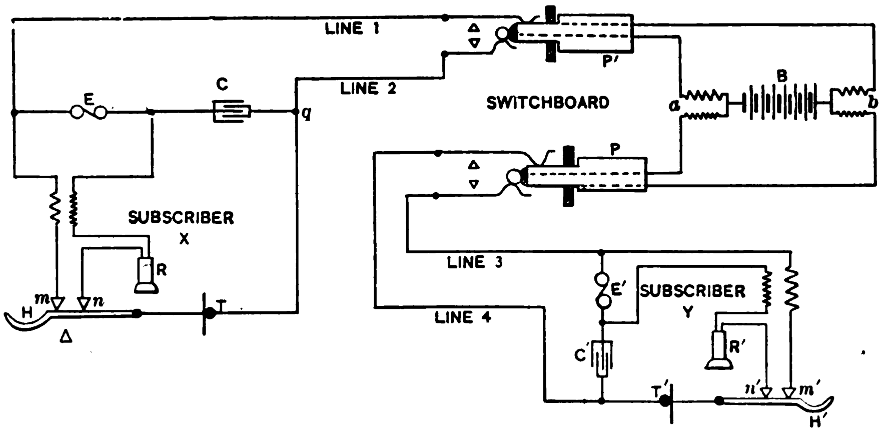


FIG. 11.—DIAGRAM OF CONNECTIONS BETWEEN TWO SUBSCRIBERS.

Suppose that the operator has rung up the subscriber desired by the original calling subscriber and released her listening and ringing keys; then the two subscribers will be connected practically as shown in Fig. 11. When both receivers are removed from their hooks, the contact points, *m* and *n*, make connection with the hook switch, H, and the contacts, *m'* and *n'*, with the hook switch, H'. This connects the transmitter and the primary winding of the induction coil across the two line wires at each station. As explained in connection with the Hayes common battery method in a previous article, the battery, B, supplies current for both of the transmitters, T and T'; the steady current from the battery passes only through the transmitter and the primary winding at each station. To be sure, there is a closed path between the two line wires through the bell, E, the secondary winding of the induction coil, the receiver, R, and the transmitter, T; but the bell magnet, E, has such a very high resistance compared with the resistance of the induction coil primary that only an insignificant amount can flow through it. Nevertheless, the receiver should be connected in this circuit so that this current in circulating around the receiver winding, although it is very small indeed, may tend to help and not oppose the magnetism of the permanent magnet.

The variation produced in the resistance of the transmitter by talking into it transforms the steady current into a fluctuating current that affects the distant receiver in a manner that will be explained. When the receiver is off the hook the latter closes not only the circuit containing the induction coil primary winding and the transmitter but it also connects the primary and secondary windings together at the contact points, *m* and *n*. Starting from the point, q, Fig. 11, there are three circuits to the line 1; one through the condenser, C, and the bell, E; another through the condenser, C, induction coil secondary, receiver, R, and induction coil primary; and the third through the transmitter, T, and the primary winding. It will also be noticed that the transmitter, T, receiver, R, secondary winding, and condenser, C, form a circuit by themselves.

In the induction coil used by the Bell Telephone Company the primary has 2600 turns of No. 24 B. & S. copper wire, and a resistance of 15 ohms, and the secondary has 1300 turns of No. 33 wire and a resistance of 30 ohms. The secondary is wound next to the iron core and the primary is wound over the secondary. The secondary and primary are so wound and connected that a current through the two in series will be flowing in opposite directions around the iron core and therefore the current in the primary winding will partly neutralize the magnetizing effect of the current in the secondary. Consequently, the induction coil does not tend to choke back an alternating current that flows through both coils in series, except in so far as one of the coils, having more turns than the other, is able, with the same current, to magnetize the iron core somewhat. The winding having the larger number of ampere-turns will, of course, have the greater magnetizing effect.

With the hook switches in the position shown in Fig. 11, the battery, B, supplies a direct current for both transmitters. As the resistance of the transmitter, T, is varied by talking into it, the steady current is changed into a fluctuating current. The fluctuations thus produced by the transmitter act on the repeating coil, *a*, *b*, at the central office, and produce in the other line circuit a fluctuating current that actuates the distant receiver, R′.

The talking currents originating at the distant subscriber's station will come over line 1 and pass through the induction coil primary. At the contact, *m*, it will divide; part of it flowing around through the transmitter, T, and part through the receiver, R, the induction coil secondary, and the condenser, C, reuniting at the point, *q*, with the portion that went through the transmitter. The entire current then returns over line 2, to the central office. The condenser, C, neutralizes more or less of the induction of the receiver and the secondary coil, and therefore the impedance of the circuit, *m*, *R*, secondary, *C*, *q*, is probably not much greater than its resistance. Consequently, the choking effect of the circuit just traced is probably very small and negligible.

Such a part of the talking current through the induction coil primary as may flow through the transmitter instead of through the receiver circuit will induce an electromotive force in the secondary winding that will cause an alternating current to flow through the circuit including the receiver, condenser and transmitter. This induced current is in unison with that part of the current from the main line that flows through the receiver circuit. The combined effect of these two currents is sufficient to properly affect the receiver, R. The bell, E, which is wound to have a resistance of 1000 ohms, offers such a high impedance to the rapidly fluctuating talking current on account of its high inductance, that these currents cannot pass through it.

◆

CORLISS VALVE GEAR AND VALVE SETTING.

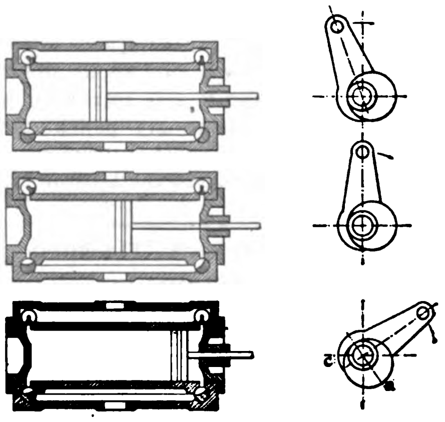
BY C. C. MAJOR.

Owing to the large percentage of power developed by the Corliss engine and its wide introduction in every line of work where economy and close regulation are of any consideration, it is essential that the engineer should understand its operation and especially its valve mechanism and adjustment. The most interesting and important part of a Corliss engine is the releasing mechanism invented by George H. Corliss in 1849. F. E. Sickles patented a drop cut-off in 1841, but as the invention of the steam engine is associated with the name of James Watt, although steam engines were built and operated before Watt's time; so the drop cut-off is most closely associated with the name of Corliss, though Sickles' patent appeared several years earlier.

Just before the appearance of the Corliss engine there was a widespread demand for an engine of superior economy and closer regulation, and as the Corliss filled these requirements to a remarkable degree, its introduction was rapid and it has maintained a commanding position for half a century and probably will not be excelled in simplicity and economy for many years to come.

The valves are four in number, two steam and two exhaust, located at the ends of the cylinder and designed to give maximum port opening with minimum clearance spaces. They usually consist of portions of cylinders oscillating within cylindrical valve-seats. The valve stems are usually of the T form and fit into slotted heads in the valves. This construction allows the valves to be removed without disturbing the stems, upon the removal of the back bonnets. Previous to about 1886 only one wrist-plate and eccentric were used, and as the single eccentric engine is limited to about one-third cut-off, it is not practical to submit these engines to heavy overloads even for short periods of time. Builders first began placing the double eccentric on the low-pressure cylinders only of compound engines, and when the engine was subjected to a heavy load, the receiver was soon emptied, as the restricted cut-off of the high-pressure cylinder allowed only a limited supply of steam to pass through. Builders now equip these engines with single or double eccentrics on both high and low-pressure cylinders, as the purchaser may desire.

The advantage of the double eccentric may be seen by noting the limitation of the single eccentric, as illustrated in Figs. 1, 2 and 3. The ratio of crank length to connecting rod is 1 to 5. Fig. 1 shows the relative positions of valves, piston, crank and eccentric, the eccentric having an angular advance of twenty degrees. The engine is turning in the direction indicated by the arrow and the eccentric has reached the dead center farthest from the cylinder giving maximum port opening as shown at the upper left-hand corner. The valve must be released now or it will not be released at all during the stroke, as the eccentric will change the direction of travel of the wrist-plate and cause the inner member, *H*, of the hook, *K*, Fig. 7, to move away from the knock-off cam, *M*; hence Fig. 1 shows the percentage of stroke traveled by the piston at the point of latest cut-off. Later cut-off can be secured by giving the steam valves a smaller amount of lap, but as the lap is as small as possible without incurring leakage, some other means must be employed. If the angular advance in Fig. 1 were made less, the exhaust valve at the lower right-hand corner would close later in the stroke and the amount of compression would be correspondingly decreased. However, the exhaust valves may be made to close at the proper point in the stroke when the angular advance has been reduced, by adjusting the exhaust-valve rods, *E*, Fig. 4.



FIGS. 1, 2 AND 3.—POSITIONS OF PISTON, VALVES, CRANK AND ECCENTRIC IN SINGLE ECCENTRIC ENGINE.

Fig. 2 shows an engine so adjusted. The eccentric is on the dead center farthest from the cylinder and the steam port has attained full opening as before, but the exhaust valve has not given full port opening, thus interfering with the discharge of the exhaust steam. Since the later point of cut-off as shown in Fig. 2 has allowed an increased amount of steam to enter the cylinder with reduced exhaust passage for its discharge, the back pressure will be increased and compression will be excessive. Fig. 3 shows the exhaust valve at the point of closing the port while the eccentric still has to travel from *a* to *c*. This large travel will give an unnecessary amount of lap to the valve and cause it to open late and prevent a full opening. The effect of shortening the rod, *E*, Fig. 4, is to make the rod and the valve crank approach more nearly to a straight line and thus reduce the travel of the valve for a corresponding travel of the wrist-plate. This trouble is obviated by the use of two eccentrics, as the steam and exhaust valves are operated independently and any desired cut-off may be obtained without interfering with the functions of the exhaust valves.

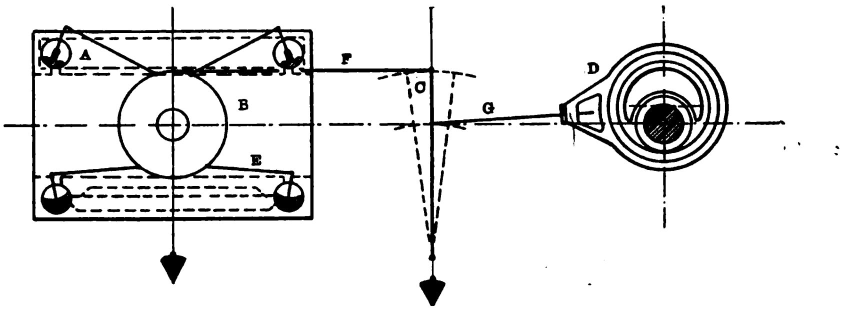


FIG. 4.—RELATIVE POSITIONS OF VALVES, WRIST PLATE, ROCKER-ARM AND ECCENTRIC.

Fig. 5 represents the wrist-plate and stud of a Corliss engine. On the wrist-plate hub will be found the mark, *a*, and on the stud the marks, *b*, *c* and *d*. When the wrist-plate is vertical, the marks, *a* and *b* will coincide, and *c* and *d* represent the amount of travel each side of the vertical. To adjust the reach-rod, *F*, and the eccentric-rod, *G*, Fig. 4, place the wrist-plate vertical, then lengthen or shorten the rod, *F*, until the rocker-arm, *C*, is vertical as shown. Turn the eccentric on the shaft to the center nearest the cylinder and note if the marks, *a* and *c*, Fig. 5, coincide. Adjust the eccentric-rod, *G*, until these marks come precisely opposite each other at the extreme points of travel of the wrist-plate.

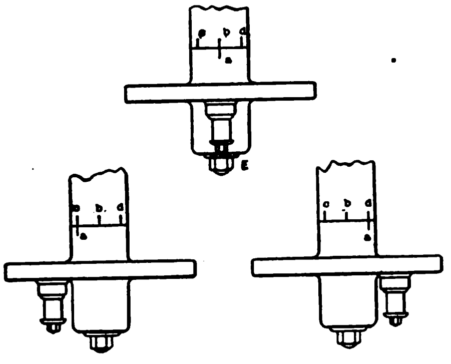


FIG. 5.—WRIST PLATE AND STUD.

If the marks above referred to are not on the stud and the wrist-plate hub, they may be made as follows: Place the wrist-plate vertical with the aid of a plumb-bob. With a chisel make the marks, *a* and *b*, on top of the hub and stud. Move the eccentric to the center nearest the cylinder and make the mark, *c*, very lightly, in line with *a*, then move the eccentric to the opposite center and make the mark *d*. With a pair of dividers measure the distances from *b* to *c* and from *b* to *d*, if they are equal, the marks *c* and *d* should be made permanent; if not, adjust either rod, *F* or *G*, Fig. 4, until they are equal.

To square the valves, that is to give them an equal amount of lap, place the wrist-plate vertical, slacken the nut, *E*, Fig. 5, and place a piece of cardboard between the washer and stud to hold the wrist-plate in position. Hook up the valves by hand and remove the back bonnets. On the valve will be seen a mark which is in line with the edge of the valve face and a similar mark on the valve-seat indicates the edge of the port. The proper amount of lap is found by consulting tables furnished by the builders, and this lap is secured by adjusting the radial rods, *A* and *E*, Fig. 4. This sketch shows the relative positions of valves, wrist-plate, rocker-arm and eccentric.

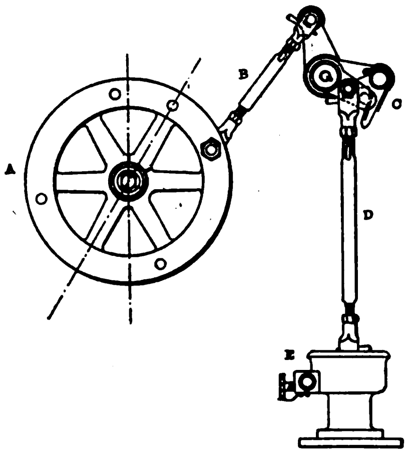


FIG. 6.—TRIP GEAR AND DASH-POT.

When the proper amount of steam and exhaust lap has been secured, the dash-pot rod needs attention. If the rod, *D*, Fig. 6, is too long, the closing shoulder on the hook will come in contact with the hook-block before the wrist-plate has reached the end of its travel and either buckle the rod or break the valve crank. If the rod is too short, the hook will not engage the block and the valve will not be opened. With the dash-pot plunger on its seat and the wrist-plate at its extreme point of travel so that marks *a* and *c* or *a* and *d*, Fig. 5, coincide, adjust the dash-pot rod so that the catch-block, *C*, will have an equal amount of clearance between the die-plate, *D*, and the closing shoulder, *E*, Fig. 7.

To set the eccentric, place the crank on the dead-center nearest the cylinder, hook up the head end steam valve and turn the eccentric on the shaft in the direction the engine is to run till the valve shows the proper amount of lead. Secure the eccentric in this position and turn the engine over to the opposite center and note if the lead is the same. If the work has been done carefully, the lead will probably be the same, but if there is a slight difference, the rods, *A*, Fig. 4, may be adjusted to secure the same amount for each valve.

In setting the exhaust valves for compression, it is difficult to tell at just what point in the stroke the valves should close to give the desired amount of compression. Assuming that the point of closure should be within two inches of the end of the stroke, measure two inches from the end of the cross-head guides and turn the engine in the direction it is to run till the cross-head is in line with the mark on the guides, then adjust the exhaust-valve rod to bring the edge of the valve in line with the edge of the port. The other exhaust-valve should be treated in a similar manner.

The next operation is to adjust the governor to produce equal points of cut-off in the stroke, or rather to allow the same amount of work to be done on each side of the piston. As nearly all Corliss engines are provided with a safety-stop in connection with the governor, it may be well to explain at least one type. Fig. 8 shows the Barclay stop with which the experimental engine at Sibley College, Cornell University, is equipped. This stop consists of a Bourdon tube, similar to that used in a steam gauge, and mounted on the side of the governor shaft. The lower end of the tube is connected to the pipe, *E*, leading to the steam chest of the engine, while the upper end is connected to the finger, *F*, through the link, *M*. When the admission valve is closed and there is no pressure in the tube, the finger will stand vertical holding up the governor by means of the block, *A*, and keeping the knock-off cams in position for latest cut-off,

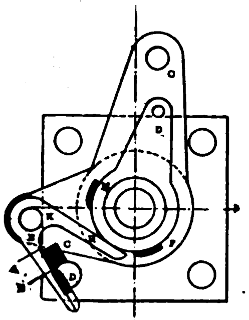


FIG. 7.

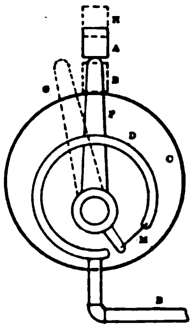


FIG. 8.

which is the most favorable position for starting. It requires from 40 to 50 pounds steam pressure to move the finger so that it will no longer support the block, and this pressure is sufficient to bring the engine up to speed and raise the block to some position such as that indicated at *H*.

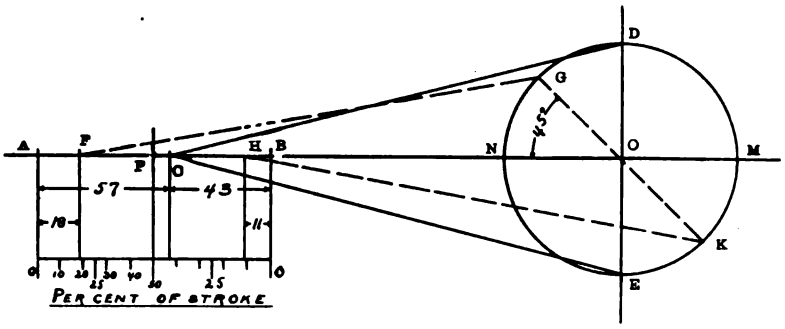


FIG. 9.—DIAGRAM SHOWING EFFECT OF CONNECTING ROD ANGULARITY.

While running under normal conditions the finger will assume the position, *G*, shown in dotted lines where it will remain until steam is shut off. If the governor belt breaks, the governor will fall until the block assumes the position, *B*, and the safety cam, *F*, Fig. 7, will be moved forward under the inner member of the hook, *H*, and throw the hook out so that the die-plate, *D*, will not engage the block, *C*. This will prevent the opening of the valve and the engine will shut down. This stop is perfectly automatic and the safety device does not depend on the memory of the engineer, which is the objection to many safety-stops otherwise quite satisfactory.

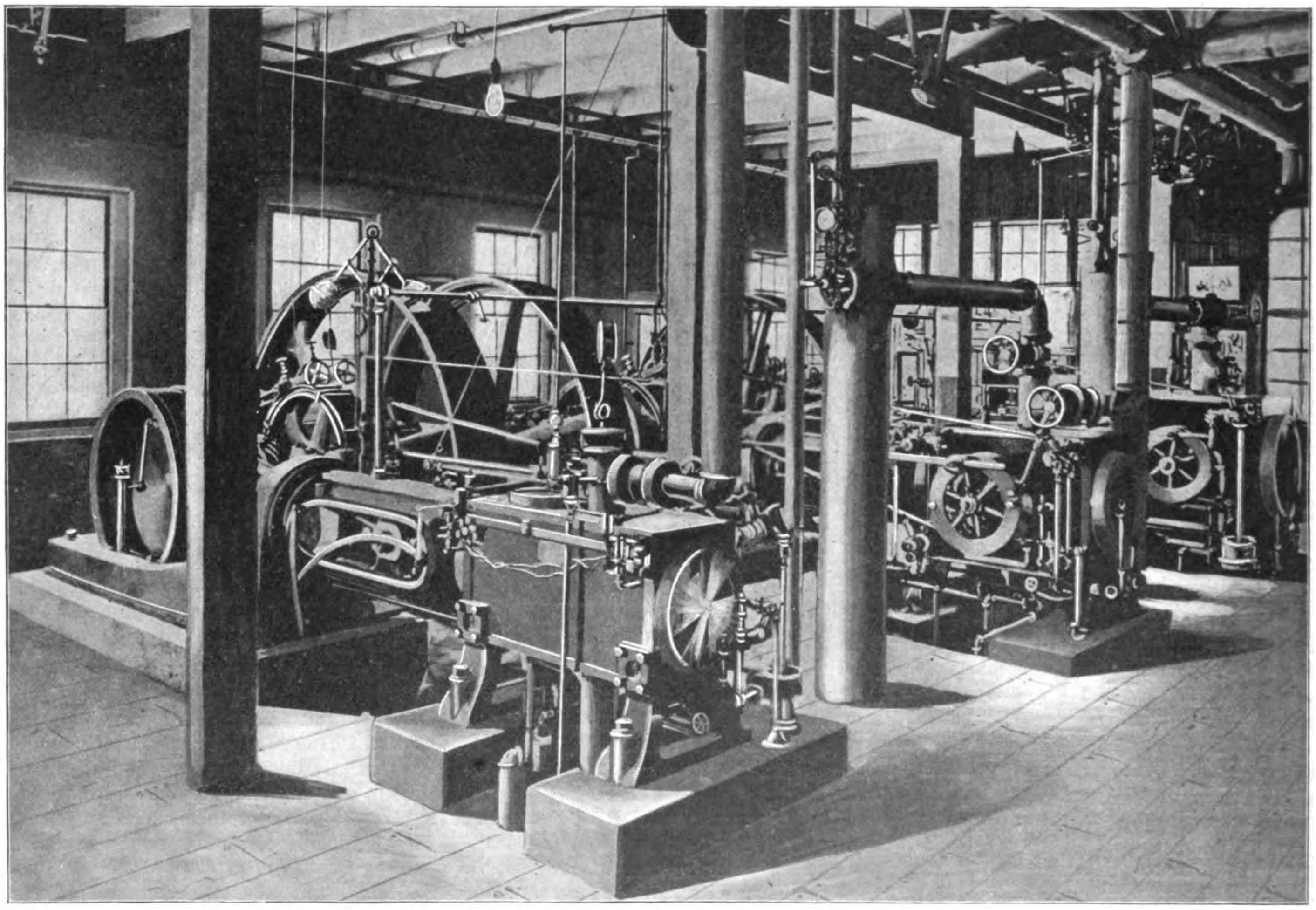


FIG. 10.—EXPERIMENTAL TRIPLE-EXPANSION ENGINE AT SIBLEY COLLEGE, CORNELL UNIVERSITY.

As the stop determines the lowest position of the governor in which the valves should hook up, place the governor on the stop, unhook the wrist-plate and with the hand-bar move the wrist-plate until the lines, *a* and *c*, Fig. 5, nearly coincide. Adjust the head-end governor-rod till the knock-off cam comes in contact with the inner member of the hook so that the valve will be released when *a* and *c* are actually in line. This operation should not be repeated for the crank end owing to the effect of the angularity of the connecting-rod. The effect of angularity is illustrated in Fig. 9. Let *A B* represent the travel of the cross-head and also of the piston, and the circle, *G M E*, the path of the crank-pin. Assume the crank to be on the center nearest the cylinder, as, *O N*; the distance, *A N*, will be the length of the connecting-rod. When the crank travels one-fourth of a revolution, from *N* to *D*, the cross-head will be at *C* or about 57 per cent of its stroke. During the second quarter revolution of the crank, the cross-head will complete its stroke and will move from *C* to *B*, or about 43 per cent of its stroke.

During the return stroke these steps are reversed, hence during the first and fourth quarter revolution of the crank-pin, the cross-head and piston travel farther than they do during the second and third quarters. Assume that cut-off occurs when the crank-pin has made one-eighth of a revolution and is at *G*; the cross-head will have travelled the distance, *A F*. On the return stroke when the crank has gone the same distance and is at *K*, the cross-head will have travelled the distance, *B H*, which is considerably less than *A F*. Under these conditions the head end will do the greater part of the work and the rotative effect given to the belt wheel will not be uniform and the regulation will be correspondingly imperfect.

To correct for the angularity of the connecting-rod when adjusting the cut-off on the crank end, block the governor up to any convenient height and turn the engine over in its direction of travel until the head end valve is released. Measure the travel of the cross-head on the guides and lay off the same distance from the other end of the guides. Turn the engine over till the cross-head is nearly to this mark and adjust the crank end governor-rod so that the valve will be released when the cross-head is even with the mark. This adjustment corrects for angularity and will give equal cut-off at each end of the cylinder, but since the area of the piston-rod diminishes the effective area of the piston on the crank side, the cut-off on that end should be a trifle later to give equal amounts of work done on both sides of the piston. An accurate and final adjustment can only be made by the aid of an indicator.

LAPS, LEADS AND TRIAL COMPRESSIONS.

Diameter of Cylinder.	Wrist Plate Central Position. Lap of Stm. Valve.	Wrist Plate Central Position. Lap of Ex. Valve.	Crank on Dead Center. Lead of Stm. Valve.	Trial Compression.
8	3/16	1/32	1/32	1½
10	3/16	1/32	1/32	1¾
12	3/16	1/32	1/32	1⅞
14	¼	1/16	1/32	2
16	¼	1/16	1/32	2
18	¼	1/16	1/32	2¼
20	¼	1/16	1/32	2¼
22	5/16	3/32	3/64	2½
24	5/16	3/32	3/64	2½
26	5/16	3/32	3/64	2¾
28	5/16	3/32	3/64	2¾
30	5/16	3/32	3/64	3
32	⅜	⅛	1/16	3
34	⅜	⅛	1/16	3¼
36	⅜	⅛	1/16	3¼

A table of laps and leads and trial compressions for engines of various sizes is given herewith and will be found convenient by engineers in charge of Corliss engines.

Fig. 10 shows the experimental triple-expansion Corliss engine in Sibley College. This engine was built by the E. P. Allis Company, of Milwaukee, Wis., from plans prepared by Dr. R. H. Thurston and Mr. Ed. Reynolds, Superintendent for the Allis Company. The main shaft is in three sections, so that the engine may be run simple, compound or triple expansion, with a proper arrangement of the valves in the system of piping shown by Fig. 11. The cylinders and receivers are shown in the center of the engraving, and the piping is so arranged that boiler steam may be admitted to any cylinder. Any one may be run alone or in combination with either of the other cylinders. Both cylinders and receivers are jacketed, and the amount of jacket steam used by each can be determined by means of the traps shown at the bottom of the diagram. The engine is used entirely for experimental purposes.

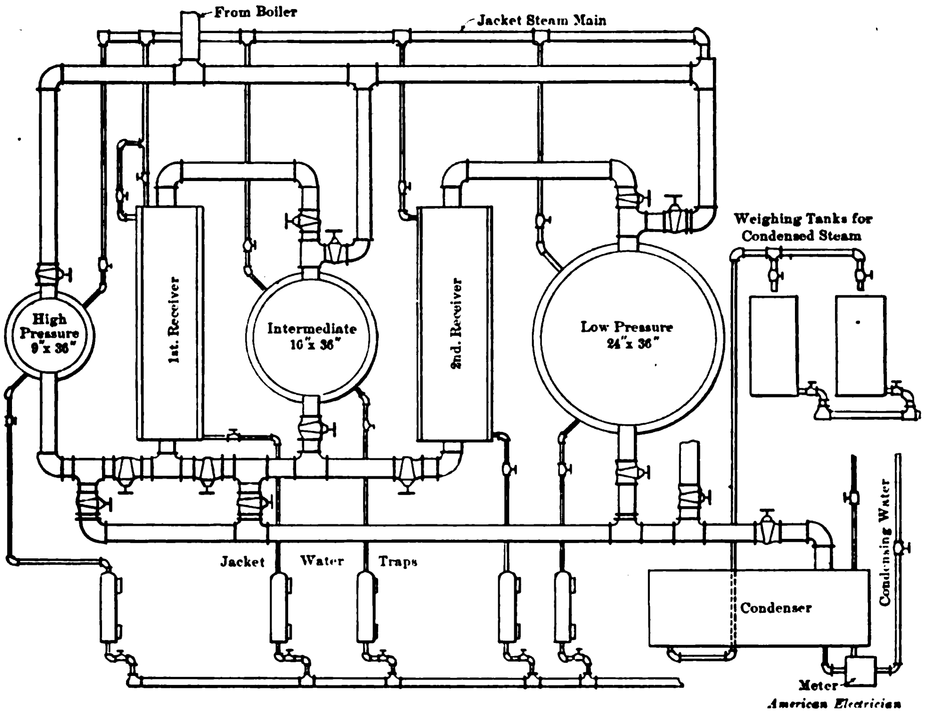


FIG. 11.—PIPING SYSTEM FOR THE EXPERIMENTAL ENGINE AT CORNELL UNIVERSITY.

◆

RAILWAY CAR NOTES.

BY ARTHUR B. WEEKS.

Car truck-boxes are to a street railway company what the man in charge makes them. That they are a neglected part of some systems is self-evident. The securely-fastened journal-cover, like the mantle of charity, covers a multitude of sins. But a car system can as well have good journals as poor ones, if the required care, as well as good material, be given them. Indeed, with proper watching, less care will be necessary, for there will be no hot boxes to call for constant attention. There certainly is no more important part of a street-railway system than this, for it is not merely a question of the cost of brass or babbitt, but the grease and oil bills are enormous where these journals are allowed to run in poor condition. The lubricant runs out at the far end of the box, distributing itself over the wheels and along the tracks, while the box may still run hot and grease may be stuffed in at every trip. Suitable material in the proper hands will count for much. Nor does the writer think that grease that is cheap enough for gears is good enough for truck-boxes.

Some of the old horse-car men used to say: "That old black oil was good enough for horse cars, why is it not suitable for electric cars?" And, strange as it may seem, some men have got no farther than that yet. But note the difference in the conditions—heavier cars, higher speed, greater mileage, with the tendency to even larger cars than ever. There is no possible chance for comparison.

A regular crop of hot-boxes is no credit to the man in charge. Of course, an occasional one is unavoidable. The writer calls to mind a plant where there were several makes of trucks for a system of twenty-six cars. Imagine the number of repair parts necessary, each make having a different size of journal and axle brasses, in addition to other parts of the boxes and the wheel bore. The company did not pretend to carry a stock for all, and that had its drawbacks, also; often cars were compelled to wait for a check brass, or some other trivial repair part. Journals were often badly worn into grooves and ridges, when all that was done was to put in the brass, keep a watchful eye on the hot box, from the first trip out to the last one in, and so on until it was worn out. In some cases, in overhauling trucks the brasses were found worn through lengthwise in the center, and the box itself worn nearly through. In many cases heavy cast-iron dust collars without any retaining spring had worn their way half an inch deep into the journals. With all that lost motion what was to retain grease or oil in the box? The side bars of some trucks were fallen in at the top, 2 to 3 ins. out of plumb, pedestal bolts badly worn and hanging on like ghosts of their former selves; the motor axle brasses had play enough to insert one's thumb in the opening.

As for lubricants, some prefer oil, with good felt and spring attachments; others use grease only. Others, again, use both, while many prefer wool waste and a special grease. Conditions vary to such an extent that one grease cannot be expected to meet all requirements. Either a good oil, with proper attention to the felt, spring and dust collars, or wool waste, is highly recommended. When once the proper lubricant has been secured, keep to it. A reduction in price of one or two cents per gallon or pound on oil or grease is no special recommendation for the brand; quality is what counts. There is no satisfaction in changing from one to another, or in trying everything that comes along. Grease cannot do it all, however; good brasses or babbitt-lined bearings must be used, with careful inspection. Steel shells, babbitt-lined, are very good. Babbitting jigs are essential in any street-railway shop for nearly all bearings.

One word more about wool waste: If one is not familiar with the method of packing a box with it, one should find out from the company supplying it their method of procedure. If it is a failure on first trial, it is probably due to improper packing or to the dust collars being so badly worn that the grease runs out at the farther end of the box. The trouble with felt and grease together is that the felt fills up with grease and a hard surface forms upon it, so that it will no longer feed the oil. Beware of a grease which cakes up after standing awhile, or fills the oilways solidly; it will give trouble. Then, as many have learned, the grease which gives the best service in winter is unsuitable for summer use, and *vice versa.* 'Frequently that which is best adapted to one make of motor will not answer for another style.

In summing up, I can only urge the use of good material, the maintenance of thorough and regular inspection of truck boxes, and renewal of them as often as necessary.

THE SPRAGUE MULTIPLE-UNIT SYSTEM

BY EDWARD CHILTON.

In the accompanying diagram the heavy lines indicate the wires and connections comprising the main motor circuits—that is, the circuits of the motors that drive the car; the light lines represent the wires of the control or pilot motor circuits. Ignoring for the present the pilot motor circuit, and assuming that the main controller, M, is operated by hand, the main motor circuit may be traced as follows: The current comes in at 1, passes through the fuse box or circuit-breaker, 2, thence through the magnetic blow-out coil, 3, coming out at the finger, 4; if the reverser is thrown up, the current passes to 5, thence to 6 connected to 5 (both being drum tips), and to the finger, L3; contacts 4, 5, 6 and L3 are the trolley fingers and drum tips on the reverser.

From the reverser finger, L3, the current goes over to the blow-out coil, 7, on the main controller. From the blow-out coil it passes to the resistance finger, R8; if the main controller is on the first notch, the current passes through all of the resistance coil to resistance finger, R1, and thence to the main drum tip opposite this finger. From the short drum tip, R1, it passes to the heavy tip, 8, connected to it, and thence to the finger +1 opposite the heavy tip, 8; then along the wire +1 the current passes to the reverser finger, +1. Now from the trolley shoe, 1, to the reverser finger, +1, the path, 1, 2, 3, 4, 5, 6, 7, R8, R1, 8, +1, +1, is the same whether the reverser is thrown up or down. That part of the circuit which includes the main drum and the resistance coil remains the same except that each successive controller notch brings into action a new drum tip which engages a new resistance finger and cuts out a new section of resistance.

When the main drum reaches the notch indicated by the dotted line, 00, all of the resistance coil is cut out and the path of the current from 1 to +1 is 1, 2, 3, 4, 5, 6, L3, 7, R8, 0, 8, +1, +1; 00 represents the last series notch. Now from the +1 reverser finger onward, the path of the current depends upon whether the reverser drum is thrown up or down. If it is thrown up, fingers +1, A1, AA1 and F1 engage tips 9 and 10 and fingers F2, AA2, A2 and + 2 engage tips 11 and 12. The path of the current from reverser finger + 1 is then +1, 9, A1, AA1, 10, F1, E1, E1, E1, E1, to main drum tips 0^1, +2, +2, +2, +2, 11, A2, AA2, 12, F2, throttle T, F2, and to the ground at G, and the motor armatures turn so as to move the car ahead. If, however, the reverser drum is thrown down, the fingers +1, A1, AA1 and F1 touch tips 13 and 14 and fingers F2, AA2, A2 and +2 touch fingers 15, 16, and the path of the current is +1, 13, 13, AA1, A1, 14, 14, F1, E1, E1, E1, E1, 0^1, +2, +2, +2, +2, 15, 15, AA2, A2, 16, 16, F2, T and F2 to G. The direction of flow of the current through the armatures has been reversed, so the armatures turn in a direction to move the car backward. It will be noticed that in both positions the current must pass through the throttle coil, T.

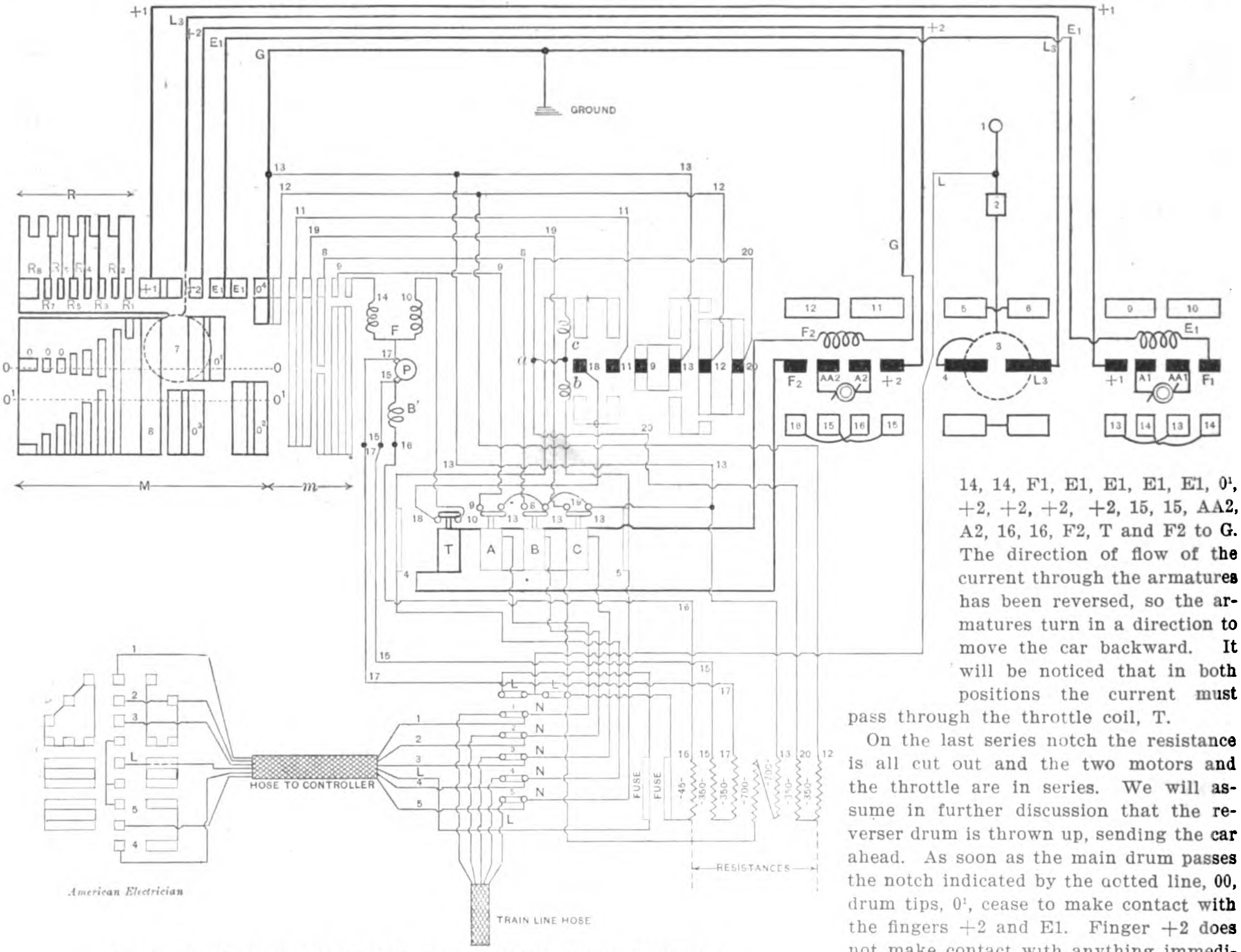


FIG. 1.—DIAGRAM OF CONNECTIONS, SPRAGUE MULTIPLE-UNIT SYSTEM.

On the last series notch the resistance is all cut out and the two motors and the throttle are in series. We will assume in further discussion that the reverser drum is thrown up, sending the car ahead. As soon as the main drum passes the notch indicated by the dotted line, 00, drum tips, 0^1, cease to make contact with the fingers +2 and E1. Finger +2 does not make contact with anything immediately after leaving tip 0^1, but finger E1 touches tip 0^2 at the same time that it touches tip 0 (E1 is a double finger), so that it makes contact with one before it leaves the other, and thereby keeps the circuit intact at that point.

Suppose that tips 0^2 and 0^3 were the same length and that both fingers, E1 and +2, hung in the air after the drum leaves the position of 00. Now remember that the finger, E1, is always the negative terminal of the No. 1 motor and that the finger, +2, is the positive terminal of the No. 2 motor. Therefore, if both of these fingers touch no contact, neither motor can get any current, and the car for the instant is entirely dead. Now, as the finger, +2, is entirely clear of any contact for a moment after leaving drum tip, 0, the No. 2 motor is cut out of circuit just that long, but the current continues to pass through the No. 1 motor by way of path 1, 2, 3, 4, 5, 6, L3, L3, 7, R8, 0, 8, +1, +1, +1, +1, 9, A1, AA1, 10, F1, E1, E1, E1, E1, 0^2 and 0^4, to G. In order to put the two motors in multiple, it is necessary first to drop at least one of them from the circuit entirely. As soon as finger + 2 touches the tip, 0^3, which is very soon after it leaves tip 0^1, motor No. 2 can get current, and the two motors are then in multiple. On the dotted line, 0_1, 0_1, which indicates the first multiple position, the path of the current from 1 to the double finger, +1, is 1, 2, 3, 4, 5, 6, L3, L3, 7, R8, R7, R6, R5, R4, R3, to the drum tip opposite the finger, R3, then to 8 and to double finger. At this double finger, +1, the current divides; part of it takes the path +1, +1, +1, +1, 9, A1, AA1, 10, F1, E1, E1, E1, E1, E1, 0^2, 0^4, G, through the No. 1 motor and the other part takes the path + 1, 0^3, + 2, + 2, + 2, + 2, 11 A2, AA2, 12, F2, T, F2, G, through motor No. 2.

It will be seen that on the first multiple notch the two motors are in multiple, but there is in series with the two all of the resistance coil included between the fingers, R3 and R8. It will also be noticed that the throttle coil, T, is in circuit with only the No. 2 motor. As the main controller drum continues to advance, the resistance fingers, R4, R5, R6, R6, and R8, come into action successively, and by degrees cut all of the resistance coil out, so that on the last main controller notch the two car motors (or four, as the case may be) are in full multiple across the line. The current path is the same as at the dotted position, $0_1 0_1$, except that the fingers, R7, R6, R5, R4 and R3 may be left out.

In the present case it is assumed that the main controller is being operated by hand, just like any other car controller, thereby eliminating the multiple-unit feature, which involves only the pilot motor and its circuit. The pilot motor simply takes the place of a man on each car. It will form the subject of a future article.

◆

The Pan-American Exposition.—Owing to the recent storms and heavy snowfall throughout the lake regions the Pan-American Exposition will only open in an informal way on May 1; the regular full-dress exercises having been deferred until May 20.

DISPOSING OF THE WATER OF CONDENSATION.

BY C. W. OBERT.

As water of condensation accumulates in a receiver, or in the chamber of a separator, or in "pockets" in the steam piping, it will need to be drained out from time to time according to the rapidity of accumulation. When such drainage is accomplished by drain cocks simply tapped into lowest points, it requires considerable attendance and care to keep the water properly drained out, and if the condensation happens to accumulate very rapidly it may become necessary to leave the drain cocks wide open to provide against emergencies when close attention cannot be given to them owing to duties elsewhere, even though this procedure will inevitably cause a great waste of steam by its blowing out with the drainage. Some engineers in meeting this contingency have endeavored to reduce the amount of steam blown out with the drainage by connecting a pipe or hose to the drain cock and running it to the bottom of a barrel of water, and then leaving the drain cock wide open all the time. This method keeps the reservoir or "pocket" drained of water very successfully, of course, and steam will not appear to be blowing to waste, but it is very questionable whether as much or more steam does not go to waste by passing down the pipe or hose with the drainage and being condensed by the coolness of the surrounding water in the barrel, than if the drainage blew out into the open air direct.

The frequent attention required to keep the accumulating condensation drained out by repeatedly opening the drain cocks and to prevent waste of steam by not leaving the drain cocks open too long may be done away with by connecting these drain cocks to some kind of self-discharging device, such as a steam trap. An improvised steam trap is sometimes adapted after the fashion of a simple plumber's sewer trap, by connecting to the drain cock one of the ends of a long pipe bent into the shape of the letter U. Free passage through this pipe is obstructed by a water seal, produced by filling the bend to some depth with water, and then the weight of the column of water forced up by the steam pressure into the outer or open leg of the U will, if properly proportioned, balance the pressure of the steam in the inner leg. As the condensation water drains down into the bend in the steam leg it will merely mingle with the water in the bend, increasing its volume and thus increasing the height of the water column in the open leg until it runs over and flows to waste. This is a very simple and easily applied device, but it is limited to very low pressures of steam on account of the great length of outer leg that would be required to get a sufficient height of water to balance high pressures. Thus, to balance a steam pressure of 90 lbs. per square inch, the water column in the open leg would need to be 208 ft. high.

For high pressures the ordinary steam trap will accomplish the discharge of the drainage automatically and very efficiently. The regular steam trap consists of a tank or receiver into which the condensation is drained, provided with a mechanism designed to open a discharge valve after the water has collected to a certain extent and to close after it has been discharged. There are several very successful steam traps on the market, among the simplest of which are those in which the discharge-valve mechanism is operated by a float. Figs. 1 and 2 show two traps that work on this principle. As the condensation accumulates in this type of trap its float rises with the water level, and at a certain point opens a discharge valve at the bottom, allowing the water to flow out. Then, as the water is discharged, the level falls and the float falls with it, eventually closing the discharge valve just before the trap is entirely emptied, so that the live steam cannot have access to and escape through the discharge outlet.

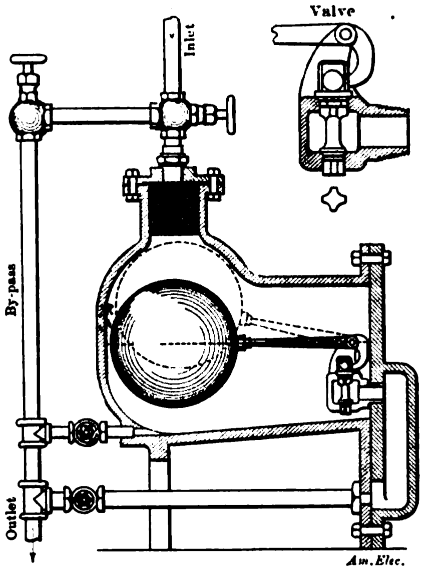


FIG. 1.—FLOAT STEAM TRAP.

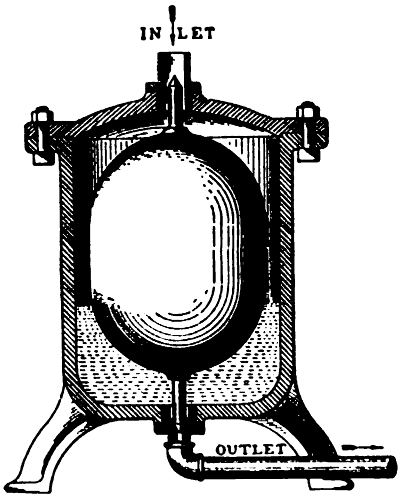


FIG. 2.—FLOAT STEAM TRAP.

In another type of steam trap the discharging mechanism is operated by the weight of the drainage water as it fills a movable bowl, or bucket, integral with the trap. These traps, two of which are shown by Figs. 3 and 4, are so arranged that the water as it enters is directed into the movable bowl or bucket until the weight of the accumulating water is sufficient to carry the bowl downward against the pull of counter-balancing weights. The downward motion actuates a mechanism which opens a valve admitting steam to the trap directly from the boiler; this steam drives the water of condensation out through a siphon or a discharge-valve opened by the mechanism. After the water is discharged, the bowl rises to its former position, thereby closing the steam and discharge valves and restoring the former conditions, ready for a repetition of the process. These traps possess the advantage of being able to discharge against a head of water, or even directly into a boiler under pressure, if the boiler is lower than the trap. The admission into the trap, during each discharge, of steam at boiler pressure makes the pressure inside the trap equal to that in the boiler, so that if the trap is on a slightly higher level than the boiler its discharge outlet may be connected to the boiler and the water will flow into the boiler by its own weight. This feature is valuable on account of the saving derived by returning the hot condensation water directly into the boiler instead of wasting it, or allowing it to cool as is usually done.

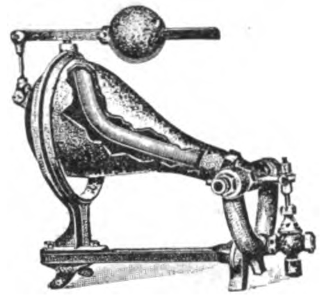


FIG. 3.—BOWL STEAM TRAP.

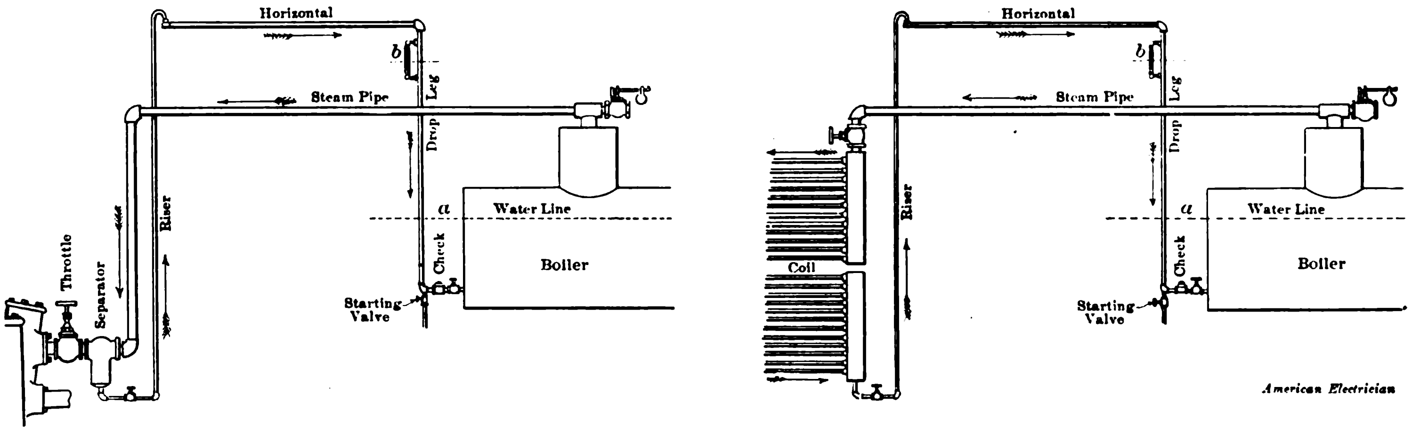


FIG. 7.—ARRANGEMENT FOR RETURNING WATER OF CONDENSATION TO BOILER WITHOUT TRAPS—FIG. 8.

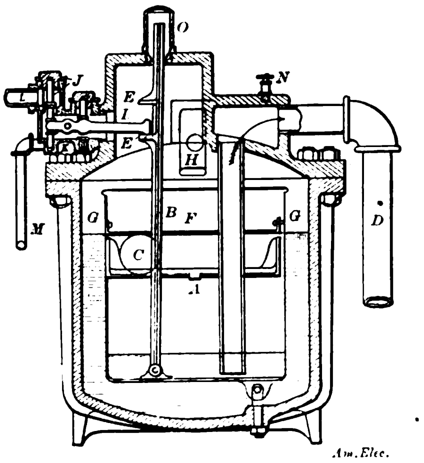


FIG. 4.—BUCKET STEAM TRAP.

A very interesting type of steam trap is one whose discharge valve is controlled thermostatically by the expansion and contraction of metal plates or rods. In this type, of which two are shown by Figs. 5 and 6, the discharge-valve is normally open at all temperatures below the boiling point of water, so that all condensation water may discharge freely; but as soon as the trap is emptied and steam begins to rush through, the higher temperature of the steam raises the temperature of the metal plates, or rod, causing them or it to expand and close the discharge-valve.

However, in spite of the ingenious designs of these steam traps, they all have one inherent and unavoidable disadvantage—the discharge-valve will inevitably corrode or wear away due to the action of the hot water of condensation and will need reseating and renewal from time to time. Attempts have often been made to reduce this trouble by using composition metals for the valves and seats, with the result that certain compositions wear much longer than others, but that none are immune from appreciable wear.

There is an extremely ingenious substitute for the steam-trap which is designed to return condensation water direct to the boiler. It combines the advantages of the boiler-return steam traps with the advantage of having no valves or mechanism to wear out. Figs. 7 and 8 are diagrams of this device, which is known as the "steam loop," and consists chiefly of a special arrangement of piping. There are three pipes, two of which are vertical and the other horizontal. One of the vertical pipes, which is called the "riser," is connected at its lower end to the reservoir, or the point of steam piping to be drained, and the other, which is called the "drop-leg," is connected at its lower end to the boiler feed pipe just outside the check. The upper ends of these two vertical pipes, which are carried up to a considerable distance above the top of the boiler, are connected by a horizontal pipe, so that this so-called "steam-loop" is simply a system of piping connecting the drip connections to the boiler-feed pipe. In starting the action of the steam loop, the starting valve, shown next to the boiler-feed check, is opened long enough for the entire loop to be filled with steam and drainage, commingled, by blowing through the loop from the drips, and thereafter, the following action takes place automatically. The steam which has been blown into the loop is condensed by the coolness of the exposed piping, thereby producing a slight drop in press-

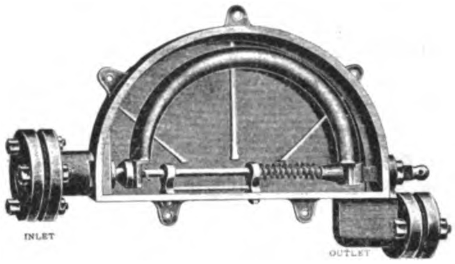


FIG. 5.—THERMOSTATIC STEAM TRAP.

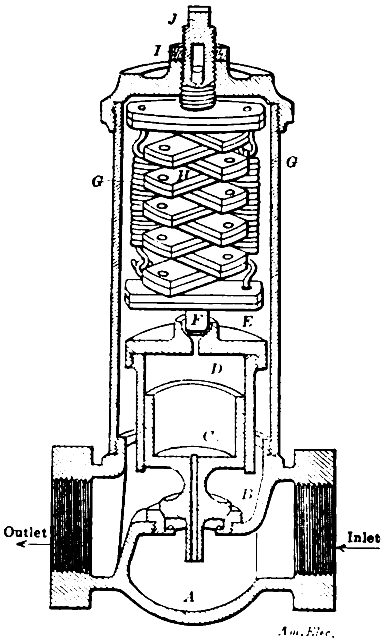


FIG. 6.—THERMOSTATIC STEAM TRAP.

ure from point to point throughout the loop, whereupon the steam pressure from the boiler will tend to rush in to make up this drop. But pressure cannot act from the boiler direct on account of the boiler-feed check next to the boiler, so it is compelled to act through the separator or drip connections, and, in doing so, it forces drainage, mixed with steam up into the riser, through the horizontal pipe to the drop-leg. This mixed steam and water becomes cooled in its passage through the pipe, thereby condensing the steam and causing another incipient vacuum, allowing more mixed drainage water and steam to be forced up the riser and into the drop-leg. When the drop-leg is filled to a sufficient height above the water line of the boiler, the weight of the water overcomes the back pressure on the check valve and it feeds into the boiler. This device is admirable for its extreme simplicity and high efficiency.

DIRECT-CURRENT DYNAMOS IN PARALLEL.

BY ALTON D. ADAMS.

Two or more shunt-wound dynamos operated in parallel at the proper speeds tend to divide the external current between them in the correct proportion, if the shunt field circuit is so adjusted that the e.m.f. generated in each armature equals the voltage at the common connection plus the "drop" in that armature when passing its correct share of current. A change of speed or poor adjustment of the magnet strength of one of several shunt-wound dynamos operating in parallel results in an incorrect division of the total current between them and in some change of line voltage. In an extreme case one of the shunt dynamos may generate an e.m.f. lower than the line voltage and thus take current and operate as a motor, doing work on its engine or driving shaft. No serious results necessarily follow, however, the polarity of magnets is not reversed and normal conditions can be at once restored by suitable adjustment of speeds and the rheotats in shunt windings.

There are two properties by reason of which shunt dynamos are operated in parallel, without any special connections. One is that, however much any one machine may lower its e.m.f., no matter whether it acts as a generator or as a motor, the magnets remain constant in polarity; the other is that changes of armature e.m.f by one dynamo does not tend to produce further change in the same direction, because the voltage at the field winding terminals cannot fall below that at the bus-bars. It is impracticable to operate series-wound dynamos in parallel with no special connection between them.

If the two dynamos are exactly alike in every way and are operated at constant speed, all will go well, but if a change of speed or some other cause lowers the e.m.f. generated in the armature of one dynamo to a point a little below that necessary to maintain its share of the current flow, the field winding of this dynamo being excited by only its reduced current, the magnet becomes weakened and reacts to further lower the e.m.f. generated in the armature. When its e.m.f. becomes less than the voltage delivered by the other machine, current will be forced through it backward by the stronger machine, and it will be driven backward as a motor, its field magnet polarity having been reversed by the reversal of current through the winding. The result of this reversal of rotation would be the throwing off of the belt and a runaway on the part of the "motoring" armature.

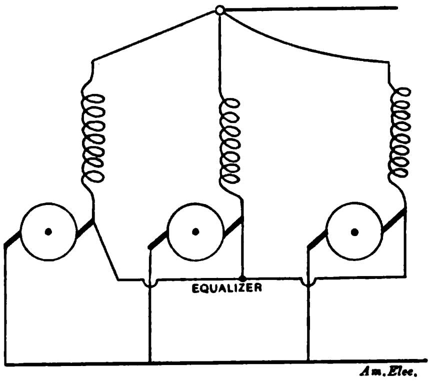


FIG. 1.—PARALLEL CONNECTIONS FOR SERIES DYNAMOS.

To prevent this reversal of current in the magnet coils of series dynamos connected in parallel, and the consequent reversal of armature rotation, the terminals of the magnet coils next to brushes must be joined, as shown in Fig. 1. The result of this third connection, commonly known as the equalizer, is that the magnet coils are all connected in parallel independent of the armatures, so that the total line current divides between the coils inversely as are their resistances, and the direction of its flow is constant. Should the e.m.f. generated in any armature in Fig. 1 drop below the voltage delivered to the common brush cables by the other armatures, the low-pressure armature would take current as a motor, but would continue to rotate in the same direction as before, since the polarity of its magnets remains constant.

Compound dynamos, having both shunt and series coils on their magnets, combine, to some degree, the properties of both shunt and series dynamos. When operated in simple multiple, they are very unstable as to the division of load between them. The same causes which produce a reversal of current through a series dynamo will produce the same result in the armature and series winding of a compound dynamo when two or more machines are operated in simple multiple. As the shunt-field winding continues to be charged at the full voltage of the system, however, the reverse magnetizing action of the series coil, when a dynamo takes current from the others as a motor, weakens but very seldom reverses the polarity of the field magnet, so that, while a machine may run as a motor, its direction of rotation is not likely to be reversed. To counteract the tendency to an unequal or disproportionate division of the load between compound-wound dynamos, recourse is had to an equalizer connection between the inner terminals of the series coils on all of the dynamos, putting them all in multiple, exactly as in the case of purely series dynamos and with practically the same result. Neglecting the resistance of the cables that form the equalizing connection, the voltage across the terminals of all series windings is the same and the current flowing through the several coils varies inversely as their resistances.

The series coil of a compound-wound dynamo is, of course, intended to produce at the dynamo terminals either a constant pressure or a certain rise in pressure as the current output increases. The effect of the series winding varies nearly with the amount of current flowing in it, and is calculated on the assumption that the amperes in the dynamo armature and in its series coil are always equal, except as to the small current of the shunt coil when this connects directly with both sets of brushes, as in Fig. 2. As the equalizer connection for compound wound dynamos renders the current in any particular series coil entirely independent of the current in its armature, the actual compounding current will correspond with the calculated current only when each of the several dynamos in parallel furnishes current in inverse ratio to its series field resistance. The ultimate effect of the series winding depends not only on its ampere-turns, but also on the magnetic density in the field magnet and armature core. As is well known, a certain magnetizing force, measured in ampere-turns, produces a much greater increase of magnetic flux when the magnet frame to which it is applied is at a low, than when it is at a much higher, stage of saturation.

Dynamos are commonly stated to be either compounded for constant pressure at their terminals or over-compounded for a certain per cent of their no-load voltage, but these particular compounding effects can only be correct for given combinations of speed, no-load voltage and position of the rheostat lever, for each dynamo. Owing to these inherent properties some care as to armature speed and shunt-field excitation is necessary to get the rated effects from the series winding

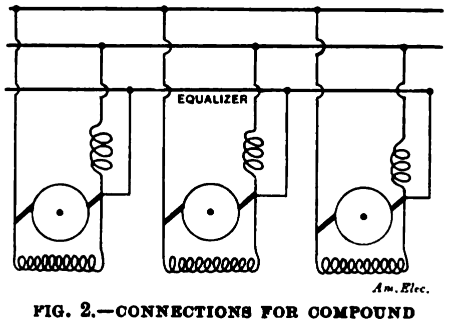


FIG. 2.—CONNECTIONS FOR COMPOUND DYNAMOS

with a single dynamo, and when several dynamos of different capacities and makes are operated in multiple, with equalizer connections, it is almost impracticable to secure the predetermined compounding effect in each machine. It is true that such dynamos are regularly operated in parallel with good results, but this is accomplished more by manipulation of rheostats than by the predetermined effects of compounding coils.

Lessons in Practical Electricity

EFFECT OF SELF-INDUCTION IN THE ROTOR OF AN INDUCTION MOTOR.

As intimated in previous Lessons, the armature, rotor or secondary, as one may choose to call it, is subject to self-induction, just like the armature of a direct-current motor. This effect, however, is greater in degree and more disadvantageous in the induction machine, as will be shown in due course.

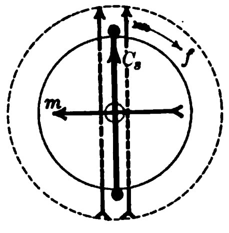


FIG. 17.—CURRENT IN PHASE.

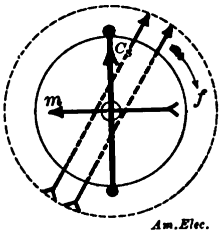


FIG. 18.—CURRENT LAGGING.

The current induced in the rotor conductors by the rotating magnetic field alternates at a low frequency, as explained last month, and as the conductors form closed circuits about an iron core they possess considerable inductance, which results in not only reducing the volume of current flowing, but in throwing that current out of phase with the induced e.m.f. that forces it through the rotor conductors. This phase displacement is illustrated by the diagrams, Fig. 17 and 18, in which a single turn or loop of the rotor "winding" is shown. (It is much easier to follow the actions in the rotor by considering a single loop, and the result is practically as accurate as though the whole squirrel cage were considered. It also simplifies matters to study a bipolar field, and this will be done throughout the Lessons on this subject. The only difference in the actions of bipolar and multipolar fields is in the rotative speed.)

In Figs. 17 and 18, a rotor core is represented having two conductors joined at the ends by wires across the heads, thus forming a closed loop. The inner edge of the stator ring is indicated by the dotted circle, the air-gap being exaggerated in order to show the position of the rotating field flux; the plane of this flux, as well as the position of its central or densest part, is indicated by double arrows across the air-gap, and the direction of rotation by the curved arrow, *f*. The e.m.f. induced in the loop will have its maximum value when the central zone or densest part of the flux, indicated by double arrows, passes across the conductors of the loop, and with no self-induction the current would do likewise, as indicated in Fig. 17, where the arrow-head, C_s, indicates the flow of induced current in the rotor loop. This current induces a cross flux in the rotor core, as indicated by the arrow, *m*, and the pull or torque between these two fluxes is greatest when they are a quarter of a mechanical cycle apart, as shown; consequently, the torque is maximum when there is no lag in the current. Self-induction, however, produces a lag in the current (the phase of the induced e.m.f. remains coincident with the mechanical phase of the field flux) and then the current in the loop does not attain maximum value until the rotating flux has passed the conductors, as indicated in Fig. 18; then the angle between the field flux and the cross flux is greater, as shown, and the torque is less. The exact relation between the current lag and the torque may be shown by the use of a few simple formulas. As it is awkward to compare the current phase with the position of the field flux in space, the phase of the induced e.m.f., which rises to maximum in unison with the passage of the flux, will be taken as the basis of comparison.

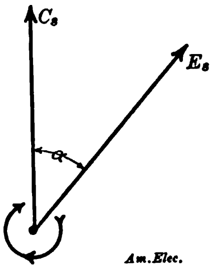


FIG. 19.—ILLUSTRATING LAG ANGLE.

If the difference of phase between the current, C_s, and the e.m.f., E_s, which forces it through the loop be represented by two vectors, as in Fig. 19, the angle, α, between the vectors will be such that its cosine is equal to the resistance of the loop divided by its impedance; thus,

$$R_s + Z_s = \cos\alpha.$$

As stated previously, the torque is maximum when the current is in phase with its e.m.f., and it decreases directly in proportion to the cosine of the angle between the two vectors representing the difference of phase between the current and the e.m.f. Thus, if there were no lag in the current. the torque exerted on one loop, in pound-feet, would be equal to $.707 \times \Phi \times C_s \times k$. In this expression, Φ is the number of magnetic lines in the rotating field flux; C_s is the current in the conductor loop, and k represents the constants necessary to reduce absolute units to practical ones. As there is always a current lag, however, the torque can be represented by the expression: $T = .707 \ \Phi C_s k \cos\alpha$. As the cosine of the angle of lag is equal to the resistance of the loop divided by its impedance, the last equation may be changed to read:

$$T = .707 \ \Phi C \frac{R_s}{Z_s} k.$$

Furthermore, as the current in the loop is equal to the e.m.f. divided by the impedance, $C_s = E_s + Z_s$, and as the e.m.f., E_s, is equal to $4.44 \times n_s \div 100{,}000{,}000$, the current, C_s, is equal to $4.44 \times n_s \div 100{,}000{,}000 \times Z_s$, and the equation for pound-feet of torque may be again changed to read thus:

$$T = \pi \Phi^2 n_s \frac{R_s}{Z_s^2} k \ldots\ldots\ldots (5)$$

in which k now includes the numerical divisor 100,000,000 (or more accurately its reciprocal) in the expression for e.m.f., and n_s is the frequency of the current in the rotor loop. This formula shows that increasing the resistance of the rotor loop will increase the torque, while any increase in the impedance of the rotor loop will decrease the torque. Now, as impedance consists of resistance and reactance combined, the resistance cannot be increased without increasing the impedance also, but it must be remembered that the increase is not directly proportional. Separating the impedance into its component parts, formula (5) develops into

$$T = \pi \Phi^2 n_s \frac{R_s}{R_s^2 + X_s^2} k \ldots\ldots (6)$$

A rough example will serve to show that if the resistance equals the reactance, a change in either direction will reduce the torque; consequently, increasing the rotor resistance will increase the torque only up to the point where the resistance and reactance become equal—beyond that, it decreases the torque. Example: Resistance = 2; reactance = 2; as the impedance, Z, is equal to $\sqrt{R^2 + X^2}$, in this case its value is $\sqrt{4+4} = 2.8284$, and the fraction, $\frac{R_s}{Z_s^2}$, in formula (5) has a value of $\frac{2}{8} = 0.25$. Now, suppose the resistance were increased to 2.1; then the impedance would be 2.9 and the fraction $\frac{R_s}{Z_s^2} = \frac{2.1}{8\text{-}41} =$ 0.2497. Again, suppose the resistance reduced to 1.9; then the impedance would be 2.759, and the fraction $\frac{R_s}{Z_s^2} = 0.24968$. In both cases, the value of $\frac{R_s}{Z_s^2}$ is less than when the resistance and reactance are equal, and the torque increases or decreases directly with an increase or decrease in the value of this fraction.

Formulas (5) and (6) also show that if the other factors remain unchanged, any increase in the frequency, n_s' of the rotor current will increase the torque. This confirms the explanation in the April Lesson of the increase in torque due to increase in "slip," the rotor conductors being "cut" by the magnetic field at a higher rate as the difference between their rotational velocities increases. Following out this line of reasoning, the torque would be maximum when the rotor stands still, as the conductors would be "cut" at the full frequency, *n*, of the magnetic field.

This would be true if the rotor had no

inductance (L_s) and consequently no reactance (X_s). ($X = 2 \pi n L$). But it has, and at standstill the reactance is about twenty times as high as at full speed. This great reactance throws the rotor current so far out of phase with its e.m.f. as to decrease the torque to a very small value, notwithstanding the great rush of current due to the high e.m.f. induced in the rotor by the high rate of "cutting" between the rotating field and the conductors. Another rough example will serve to illustrate this point. Formula (6) shows that the torque is directly proportional to

$$n_s \frac{R_s}{R_s^2 + X_s^2}.$$

Now suppose that the resistance, R_s, of the single loop is 0.005 ohm and its inductance, L_s, 2½ millihenrys, or 0.0025 henry. Now with a primary frequency of 60 cycles and a 5 per cent slip at full speed, the rotor frequency will be .05 × 60 = 3 cycles, and the reactance ($2 \pi n_s L_s$) of the one loop will be $2 \pi 3 \times 0.0025$, or 0.0047124 ohm. Substituting these values in the above expression, we get

$$n_s \frac{R_s}{R_s^2 + X_s^2} =$$

$$3 \times \frac{0.005}{.000025 + .0000222} = 317.8,$$

so that the torque is $317.8 \pi \Phi^2 k$ at full speed. Now at standstill the rotor frequency is the same as the primary frequency—60 cycles. The reactance then will be $2 \pi 60 \times 0.0025$, or 0.94248 ohm, and

$$n_s \frac{R_s}{R_s^2 + X_s^2} =$$

$$60 \times \frac{0.005}{.000025 + .88827} = 0.33765.$$

Consequently, the torque at standstill will be only $0.33765 \pi \Phi^2 k$ pound-feet, the difference between this torque and the full load torque being in the ratio, roughly, of 318 to 0.338. It is because of this effect that the rotors of large motors are provided with coil windings and slip rings whereby an external resistance may be inserted in the rotor circuit. Suppose, for example, that the terminals of our single loop were led to two slip rings (like the collector rings on an alternator) and the brushes of those slip rings connected to a resistance of 0.935 ohm; then the total resistance would be 0.94 ohm, the reactance at standstill, 0.94248 ohm, and the starting torque, $32 \pi \Phi k$ pound-feet, or nearly 100 times the standstill torque without external resistance.

Letters on Practical Subjects

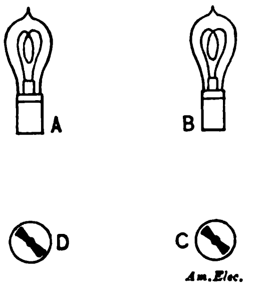
A Problem in Connections.

To the Editor, American Electrician;

Sir:—I would like to ask if any of your readers can solve the following problem: In the accompanying diagram, A and B are incandescent lamps; C and D are switches. The problem is to arrange the connections so that the lamp A can be lighted by means of the switch D, and when this is done the lamp A may be cut out by the switch C. Now it is desired that the switch C will either relight the lamp A alone or light both the lamps, A and B, at the same time, and with both of these lamps lighted they may be turned out by the switch D and the series of operations just described carried through again. I have not been able to solve the last part of the problem, and will appreciate it if some of your readers will suggest a solution. The switches are represented as snap switches, but it is not intended to limit the form of switch to be used.

George Moutonnet.

Saumur, France.



LAMPS AND SWITCHES.

Boosting Transformer Switch Connections.

To the Editor, American Electrician;

Sir:—Referring to Mr. C. C. Webster's letter in your March issue, I beg to disagree with the statement that in the case of Fig. 4 the e.m.f. would rise in the primary, due to an increase of current in the secondary during the time when the switch is being thrown from one position to the other. A moment's study will show that the secondary carries the full line current whether working as a booster or during the change of position, so that in no case would the primary e.m.f. rise above normal. Fig. 3 in Mr. Webster's letter, and Fig. 5 in Mr. Wood's letter, in the same issue, are both open to the very serious fault that they open the line during the change of position. This fault is not possessed by Fig. 4, which seems to be the correct connection.

Chelsea, Mass. E. W. Lothrop.

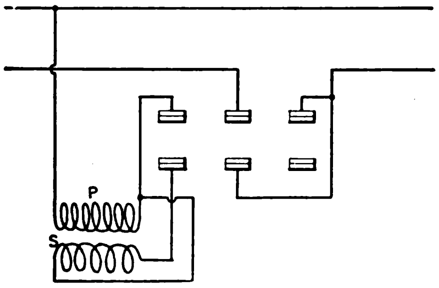


FIG. 3.

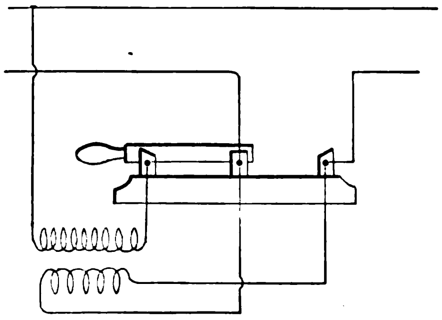


FIG. 4.

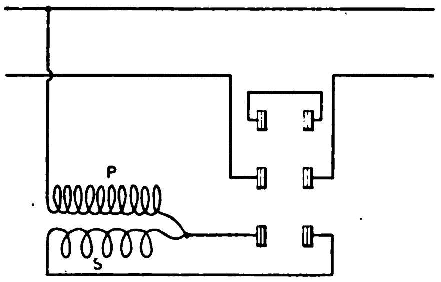


FIG. 5.

DIAGRAMS OF SWITCH CONNECTIONS FOR THROWING OUT BOOSTER DURING LIGHT LOADS.

Operation of Engine-Driven Alternators in Parallel.

To the Editor, American Electrician;

Sir:—It has been said that the varying crank impulses of an engine at different angles cause "pumping" or hunting by an alternator, but the writer's observation leads to the conclusion that this is not serious in itself, because engines will sometimes run for an hour or more without indications of cross-currents and then apparently without reason the alternators will begin to pump. If the variations of the crank effort during one stroke cause the disturbance it ought to exist at all times; otherwise, such a conclusion is illogical.

In throwing one alternator in parallel with another it is found necessary to throttle the engine until its speed corresponds to the speed of the active machines and then throw in the switch. Under these conditions it is impossible to make the speed of the fresh engine exactly like that of the loaded engines, but the variation is so sluggish that there is plenty of time to couple the alternators at the proper moment; not, however, without causing some cross-currents. However this may be, when they are once in operation and it is desired to uncouple one from another, the machine to be thrown out is gradually slowed down by throttling until the load is nearly off and then the switch is pulled, and this operation causes no disturbance whatever. From these facts it seems reasonable to assume that the tendency of an engine to slow down under these conditions is not detrimental to the operation of alternators in parallel, but that the trouble comes from the tendency, due to variations of steam pressure or other causes, to go beyond normal speed.

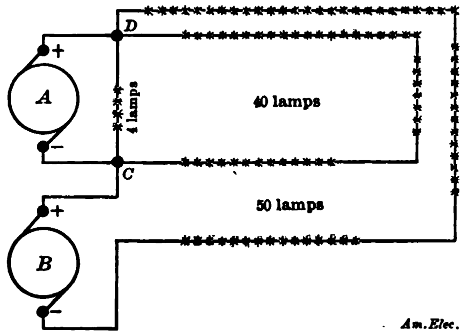
It was with this idea in mind that a dash-pot was designed in such a way as to offer great resistance to the tendency of the cut-off to lengthen and only the very slightest resistance to the tendency of the cut-off to shorten. Such an arrangement, while not adapted to rapidly fluctuating loads, is suggested as a solution of the problem of hunting or pumping. Ralph J. Patterson.

Woburn, Mass.

An Arc-Lighting Problem.

To the Editor, American Electrician;

Sir:—The accompanying diagram illustrates a curious accident which occurred some time ago on two of our arc lighting circuits. The dynamos shown in the diagram are Brush machines of the ordinary type; the dynamo, *A*, supplies 40 light and the dynamo, *B*, supplies 54 lights normally. The accident referred to consisted of a cross between the two circuits, as indicated by the dots, *C* and *D*, where the line from the positive pole of the dynamo. *B*, crosses both of the line wires of the other circuit. Four lamps were caught in between the two crosses, as indicated in the diagram. It may be interesting to some of your readers to figure out what happened when the cross occurred. The lamps take 50 volts each and the line current is 10 amperes. What is the distribution of the current; what is the action at the dynamos, and what happens to the four lamps between the points *C* and *D*?



CROSSED ARC LIGHTING CIRCUITS.

Waterbury, Conn. F. M. Swalm.

Bucking of Railway Generators.

To the Editor, American Electrician;

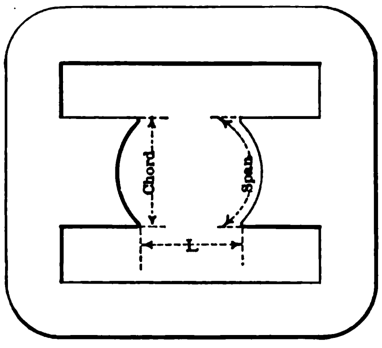
Sir:—In Mr. Parham's interesting article on the "Bucking of Railway Generators," which was printed in your February number, one part of the explanation of this trouble seems to be incomplete, and the other part at variance with common practice. In all small railway power houses there are prolonged periods when the load is zero and in such cases the load fluctuates violently between zero and maximum and even considerable overloads without any bucking whatever on the part of the generators. The writer has operated machines under these conditions for several years and never had the slightest trouble from bucking. A more plausible explanation would seem to be that the magnetic characteristics of the two dynamos are so different that they cannot be made to divide the load properly under different loads, and although they may have been adjusted to give the same e. m. f. when they were thrown in together, the station attendant will almost always re-adjust the fields afterward so that the load is divided equally under average load. If the magnetic characteristics of the machines differ very greatly the e. m. f. of one of them will be considerably higher than the other at no load if they are adjusted to divide the load equally at average or full load, and the action which Mr. Parham describes will take place. Mr. Parham is evidently wrong, however, in supposing that the series fields of the dynamos have anything to do with the bucking; series field windings are always connected in parallel by the equalizer bus-bar, so that it is impossible for the armature of one machine to back current in the demagnetizing direction through the series field coils of another. Ed. S. Morgan.

Denver, Colo.

Pole-Piece Dimensions.

To the Editor, American Electrician;

Sir:—Having occasion to calculate the span of pole-pieces and the chord of the tips (distance straight across) I recently prepared the accompanying table to save time and trouble in figuring out each case. I submit it in the hope that it may be of service to some of your readers who are engaged in drafting or similar work.



BIPOLAR FIELD MAGNET.

The figures in the body of the table give the chord, span, etc., in inches per inch of polar bore for various percentages of polar span. For example, an armature chamber is to have a bore of 12 ins.; the field is four-pole and the pole-pieces must cover 74 per cent of the armature surface. What is the chord? The table gives 0.549 in. as the chord per inch of diameter for four poles covering 74 per cent; 0.549× 12 = 6.588 ins. Of course, 6.6 ins. would be near enough.

Per cent of Armature Covered by Pole Pieces.	2 Poles.			4 Poles.			6 Poles.			8 Poles.		
	Pole Chord.	Pole Span.	Coil Leng'h L.	Pole Chord.	Pole Span.	Coil Depth T.	Pole Chord.	Pole Span.	Coil Depth. T.	Pole Chord.	Pole Span.	Coil Depth. T.
50	.707	.785	.707	.383	.393	.271	.259	.262	.448	.195	.196	.36
52	.724	.817	.684	.397	.408	.26	.269	.272	.43	.203	.204	.346
54	.75	.848	.66	.412	.424	.25	.279	.283	.413	.21	.212	.332
55	.76	.864	.649	.419	.432	.245	.284	.288	.404	.214	.216	.324
56	.77	.88	.637	.426	.44	.239	.289	.293	.395	.218	.22	.317
58	.79	.911	.612	.44	.455	.229	.299	.304	.377	.226	.228	.303
60	.809	.942	.587	.454	.471	.218	.309.	.314	.36	.233	.236	.289
62½	831	.982	.555	.472	.491	.205	.321	.327	.337	.243	.245	.27
66⅔	.865	1.047	.5	.499	.524	.183	.342	.349	.3	.258	.262	.24
70	.891	1.1	.454	.522	.55	.165	.358	.366	.27	.271	.275	.217
72	.905	1.131	.425	.536	.565	.154	.368	.377	.253	.279	.283	.202
74	.918	1.163	.397	.549	.581	.143	.378	.388	.235	.286	.291	.187
75	.924	1.178	.382	.556	.589	.138	383	.393	.226	.29	.295	.18
76	.93	1.194	.368	.562	.597	.132	.387	.399	.217	.294	.298	.173
78	.941	1.225	.338	.575	.613	.12	.397	.408	.199	.302	.306	.159
80	.951	1.257	.308	.588	.628	.11	.407	.419	.18	.309	.314	.145

To ascertain actual dimensions multiply the figures in the body of the table by the bore of the pole-pieces.

The column headed "L" contains the maximum length of coil that will go between opposite poles of a bipolar ironclad field, per inch of polar bore. Those headed "T" contain the maximum *thickness* of coil that can be put on a multipolar field magnet which has no removable pole-shoes, such as Fig. 2. The sketches serve as a key to all of the table headings.

George W. Malcolm.

Brooklyn, N. Y.

Adjusting an Electrodynamometer.

To the Editor, American Electrician;

Sir:—In your March issue I notice a note on the use of electrodynamometers; I would like to add a simple test. After having performed the manipulations stated in the article, short-circuit the movable coil at the mercury cups and pass a not too strong alternating current through the instrument. If the adjustment is correct the pointer will remain stationary. If the adjustment is not correct the pointer will be deflected owing to currents being induced in the movable coil. The current passing through the movable coil owing to its being shunted across the short circuit is too small to affect the instrument.

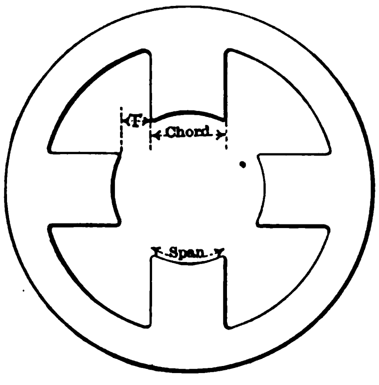


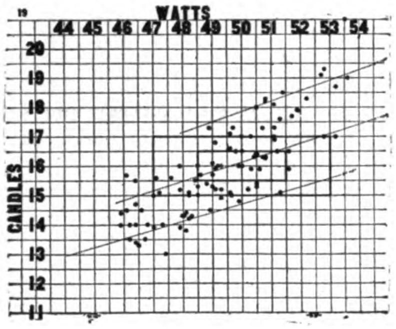
FIG. 2.—FOUR-POLE FIELD MAGNET.

Allegheny, Pa. P. M. Gallo.

Electrical Catechism

593. What is meant by a target or shot-gun diagram?

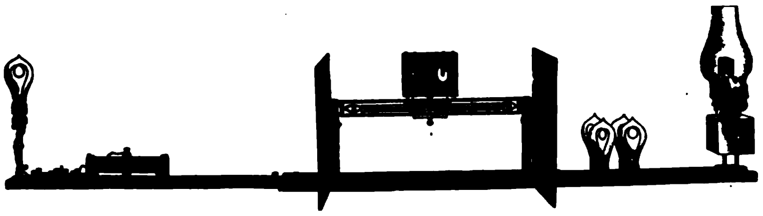
A target diagram shows the watts absorbed and the candle-power of a number of lamps which are tested for uniformity. Such a test should be made for each lot of new lamps bought. The lamps are each placed on a photometer and subjected to the voltage marked on the lamp case, and the watts and candle-power measured at the same time. The readings for each lamp are recorded and also plotted on a sheet. The record of a test of a poorly sorted lot of lamps is shown in the accompanying target diagram.



TARGET DIAGRAM.

594. What is a photometer?

The photometer is an apparatus for measuring light. The lamp to be tested is placed at one end of a bar, a standard lamp of known candle-power is placed at the other end, and each is subjected to the voltage specified. A movable screen or "sight box" is then moved along the bar between the two lights until its two sides are equally lighted by the two lamps. When a balance is found, the strengths of the two lights are inversely as the square of the distances from each light to the sight box screen. At the same time the volts and amperes are measured for the lamp under test, and the watts are calculated by multiplying volts by amperes.



PHOTOMETER.

595. What is the temperature of the filament in an incandescent lamp?

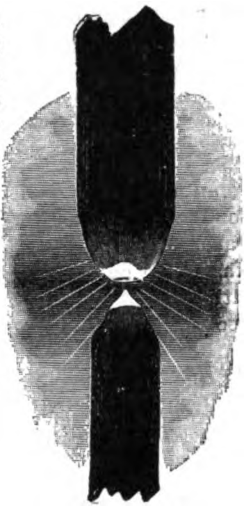
The temperature is from about 3092 to 3812° Fahrenheit. If the voltage is too high the lamp takes too much current, and the temperature of the filament becomes so high that it becomes soft and droops until it may touch the glass bulb, which then cracks and allows air to enter and burn the filament. An abnormally high temperature also causes disintegration of the filament and causes its candle-power to drop off rapidly.

596. How many incandescent lamps are in use?

It is difficult to estimate closely. There are from 15,000,000 to 20,000,000 lamps sold yearly in America, and the European demand probably increases these figures to about 25,000,000. The total number of lamps in service is probably several times the latter figure.

597. What is the electric arc?

The electric arc is a phenomenon discovered by Davy about 1800. He sent a strong current through two carbon pencils and then separated them. The current continued to pass, raising the temperature of the ends of the carbons to a high degree, while a vapor of carbon passed between the carbon pencils. By reason of the rising currents of air the stream of incandescent vapor between the pencils assumed an arched form, and Davy named it the electric arc or arch. Later experiments show that the end of the positive carbon is raised to the temperature of volatilization, that of the arc itself being higher and that of the negative carbon being lower.



ELECTRIC ARC.

598. What is the source of the light from an arc?

Almost all of the light comes from the end of the positive carbon, which is heated by the current. In the case of alternating-current arcs the light comes equally from the ends of both carbons. In most lamps the carbon pencils are together at the start, but are immediately separated by the lamp mechanism. The current meets great resistance as the carbons separate, and the energy absorbed heats the ends of the carbons until the end of the positive carbon begins to vaporize and furnish a path of incandescent vapor between the two pencils. The end of the positive carbon assumes a cup shape, which is called the crater, and from this proceeds a clear white light. The purple or violet light that sometimes becomes prominent, comes from the arc itself.

599. Does the light of an arc come from the combustion of the carbons?

The light comes principally from the positive crater and to a small extent from the arc itself. The carbons burn so slowly that the light from ordinary combustion is negligible except under abnormal circumstances. When the arc is too short or the current too large, or the carbons too soft, a flame plays around the arc and burns the carbons rapidly. This flame is not so luminous as the arc or the crater, and it actually reduces the amount of light.

600. How rapidly do the carbons burn ordinarily?

A positive carbon 12 ins. long and 0.5 in. in diameter will burn from 7 to 12 hours. The negative carbon lasts from one to three and one-half times as long as the positive, varying with the voltage of the arc. The life increases as the diameter increases. When the arc is enclosed the carbons last much longer, a single pair lasting from 50 to 150 hours. The life of the carbon depends upon the current, the pressure, the condition of the air, the manufacture of the carbon and the amount of plating on its surface.

601. What are enclosed arc lamps?

With the enclosed arc lamps a small glass globe surrounds the arc and fits the carbon pencils so closely that the air inside the globe can change only slowly. This reduces the rate of combustion of the carbons, so that they last longer. This not only reduces the frequency of retrimming (re-carboning) the lamp, but also reduces the demands upon the feeding mechanism of the lamp. The gas within the globe seems to glow and increase the apparent amount of light more than the glass diminishes it. The enclosed lamps are so much more satisfactory in their operation that they are rapidly replacing the open arcs for interior illumination and are being used to some extent for outdoor lighting. They are the cause of a large increase in the total amount of arc lighting furnished.

602. What currents are used in arc lamps?

The standard current for a street arc lamp is 9.6 to 10 amperes, or 6.8 amperes for "half arcs." Enclosed arc lamps take from 2 to 10 amperes. Arc lamps of the open type take as high as 15 amperes. Searchlights take as high as 200 amperes.

603. What voltages are used in the arcs?

The smallest pressure that will maintain an arc is about 18 volts. Arc lamps for alternating currents are often operated on 28 to 33 volts. Ordinary open arc lamps such as are used for street lighting take from 40 to 60 volts. Enclosed arcs take from 60 to 160 volts at the arc.

604. On what kind of circuits are arc lamps operated?

Arc lamps were formerly operated almost exclusively on series circuits in which a dynamo maintained a constant current. Arc lamps are now operated upon any kind of circuit giving 28 volts or more. The general tendency is to simplify the machinery in electric stations and to use the same dynamos for furnishing current for all purposes, consequently the arc-light machines does not command the attention it did a few years ago.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

How can two alternators connected in series be brought into phase with each other?
E. A. W.

Two alternators cannot be operated satisfactorily in series for the reason that they will not stay in phase.

What is meant by the expression "circular mils?"
E. M. S.

A circular mil is the unit of circular area of the cross-section of a wire. It is equal to the diameter of the wire in mils multiplied by itself. A mil is 1/1000 inch.

Can a 110-volt direct-current ceiling fan motor be charged to run on a 104-volt 60-cycle alternating-current circuit by exciting the fields separately?
W. P. P.

Not satisfactorily; the sparking at the brushes would soon destroy the commutator; moreover, the speed would be absurdly reduced by the high self-induction of the armature.

Why will not a 110-volt direct-current fan motor, driven as a dynamo by an alternating-current fan motor give any e.m.f. at the binding posts?
W. T. S.

Because the direct-current machine is series-wound and the fields are not excited until the full-load current passes through.

Is the carrying capacity of a wire affected by the length of the wire? (2). What determines the voltage of a dynamo or motor?
G. I. B.

Not unless the wire is wound into a coil. (2). The number of wires on the armature, the strength of the magnetic field and the rate at which the armature revolves.

What is the effect of using a cored upper carbon instead of a solid carbon in an alternating-current arc lamp?
C. G. H.

The core being softer than the shell, it is burned away more rapidly and forms a slight crater in the upper carbon, increasing the effectiveness of the illumination below the lamp. This also centers the arc between the carbons and prevents it from traveling around erratically.

How many square inches of surface are required on the positive plates of a storage battery per ampere of current? (2). How many circular mils of cross-section should be allowed in the wire of an armature winding per ampere of current? (3). How is the drop in voltage through a known resistance found?
F. M.

About eighteen. (2). From 400 to 800 circular mils, according to the radiating surface of the armature and its speed. (3). By multiplying the resistance in ohms by the current which passes through it.

What size plates should be used for a storage battery to discharge one ampere for six hours? (2). How can I tell when the battery is charged without inspecting?
E. F. W.

Use two positive plates 2½ x 4 ins. and one negative plate the same size. Apply the paste only to the faces of the positive plates next to the negative plate. (2). By connecting a voltmeter to the terminals. When the e.m.f. exceeds 2½ volts the battery is near enough charged for practical purposes.

Does compression increase the economy of a steam engine, and why is higher compression used with high-speed engines than with the Corliss type?
E. B. L.

This is an unsettled question; some builders claiming that high compression increases the economy and others disputing that claim. Some compression is necessary in order to cushion the piston at the end of each stroke and make the engine run smooth, and the higher the speed the more compression is required for this purpose.

Can an alternator be installed in place of a direct-current generator for lighting purposes without changing the wiring?
H. J.

As a general rule, no. This depends, however, upon what plan of wiring has been used in connection with the direct-current machine, and also upon the voltage of the alternator that is to be put in. If the voltage of the latter machine is the same as that of the direct-current machine then, of course, no change in the wiring is necessary; this would be a very unusual case, however.

Please explain why a magneto will ring through the secondary core of an induction coil when the primary coil and core are removed, and will not ring when the primary coil and core are in place unless the primary coil is short-circuited.
W. R.

Because the inductance of the secondary coil when the core is in it is so high that the counter e.m.f. of the coil opposed to the magneto e.m.f. reduces the magneto current to a value too small to ring the bell. When the primary coil is short-circuited; the mutual induction between the primary and secondary reduces the counter e.m.f. of the secondary coil and the magneto is enabled to ring through it.

Should the block across the upper ends of the magnet cores of an Edison bipolar dynamo be called the yoke or the keeper? (2). Is the "neutral" point on a commutator the point of commutation or the point midway between the brushes, where the e.m.f. is zero? (3). Is the "commutation" point the point on which the brushes actually rest, or the point on which they would rest if there were no field distortion?
J. E. B.

The yoke. (2). The term "neutral" has been applied to both of these points, but it is most commonly applied to the point on which the brush would rest if there were no field distortion. (3). The commutating point is invariably the one upon which the brush actually rests.

What is meant by "wattless current?" (2). How can I construct an automatic damper regulator for a 75-h.p. boiler? (3). Would the horse-power of a boiler be doubled by doubling the heating surface?
G. L.

There is no such thing as wattless current; the wattless component of a current is the component which is out of phase with the e.m.f. by 90 degrees. (2). We cannot undertake to furnish designs for apparatus; moreover, you would not be able to build a satisfactory automatic damper regulator unless you had excellent shop facilities. (3). Yes, provided it is the effective heating surface that is doubled.

Does it make any difference in telephone work which terminal of the induction coil is connected to the positive pole of the battery? (2). If not, why is it that in a singing test of a telephone receiver reversing the battery makes quite a difference in the result?
H. R. E.

Not a particle. (2). Because the telephone receiver magnet cores are polarized by the permanent magnet, so that the vibration of the diaphragm tends to amplify the battery effect if the battery is connected one way, while it tends to diminish it if it is connected the opposite way.

Can I cut out a damaged armature coil in a revolving-field three-phase alternator, or should the coil be taken entirely out of the slots? (2). Can a damaged field coil be short-circuited, or should it be removed in order to continue running?
H. E.

The damaged coil may be disconnected from the armature circuit and its place bridged over with a piece of wire; the safest plan, however, is to remove the coil entirely, as the e.m.f. induced in it may damage it still further and extend the damage to neighboring coils. (2) The field coil may be simply short-circuited and left on the pole in order to maintain the mechanical balance until a perfect coil can be substituted.

What is meant by the "duty" of a pumping engine?
P. P. W.

Formerly the duty of a pumping engine was the net foot-pounds of work delivered per 100 lbs. of coal burned under the boiler, and some persons still adhere to this definition. As the quality of coal varies widely, however, the American Society of Mechanical Engineers recommends as the unit of duty the number of foot-pounds of work delivered per 1,000,000 heats unit supplied to the steam cylinders of the engine. Put in formula shape this would read as follows:

$$\text{Duty} = \frac{1,000,000 \times \text{net foot-pounds}}{\text{B. T. U.}}.$$

How can I equalize the clearance in a cylinder without taking off the cylinder heads?
A. R. T.

Disconnect the connecting-rod from the cross-head and push the cross-head back until the piston strikes against the back head of the cylinder; then scratch a mark on the cross-head guide opposite a mark on the cross-head itself. Pull the cross-head forward until the piston strikes the front cylinder head and make another mark on the cross-head guide opposite the mark on the cross-head. Then couple up the connecting-rod and turn the engine over, adjusting the piston rod in the cross-head block until the mark on the cross-head comes within the same distance of each of the marks on the cross-head guide at the ends of the strokes. This assumes that the back surface of the piston corresponds with the inner surface of the back cylinder head to exactly the same extent that the front side of the piston corresponds with the front head; consequently, if the two facing surfaces do not correspond in the same ratio this method will not be entirely accurate, but it will ordinarily be sufficiently accurate for all practical purposes.

A QUICK-CLOSING WATER GAUGE.

Fig. 2 herewith illustrates a quick-closing water gauge manufactured by Paul B. Huyette, of Philadelphia, and Fig. 1 is a sectional view of the valve which is used on this gauge. It will be observed that the stem of the valve is provided with a screw thread of coarse pitch so that instead of requiring several revolutions to close or unclose the orifice connecting the water gauge with the boiler only a partial turn is necessary. This motion is given to the valve stems through the medium of chains hanging within convenient reach of the fireman, as indicated in Fig. 2. It will be entirely obvious that the gauge may be shut off from the boiler in the event of the breakage of the water glass or other accident without the slightest danger of injury to the fireman. Even in the event of the blowing out of the pet cock, usually located at the bottom of the water glass but not shown in the illustration, the fireman can shut off the gauge at a safe distance by using a piece of stout wire with a hook in the end of it, by means of which he can catch the chain and pull it without standing directly beneath the water gauge.

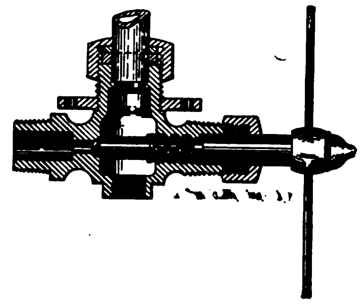


FIG. 1.—SECTIONAL VIEW OF VALVE.

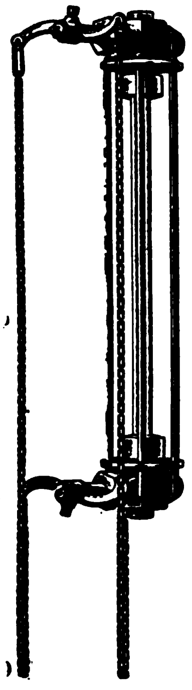


FIG. 2.—WATER-GAUGE.

◆

S. K. C. FREQUENCY CHANGER.

A machine for changing the frequency of alternating currents is usually somewhat complicated both in construction and operation. Built of the ordinary type it consists of an induction motor with a wound rotor, the rotor circuits being connected to slip rings and delivering currents at a different frequency from that of the currents supplied to the stator winding. The induction motor is direct-driven by a synchronous motor, so that it really becomes an induction generator; its rotor is driven in the opposite direction to that which it would take if it were allowed to run as a motor.

The inductor type of generator, however, lends itself to frequency changing with beautiful facility, as is exemplified in the case of the S. K. C. machine illustrated herewith. It is doubtless well known to all of our readers that the S. K. C. alternator comprises two stator rings or crowns on which are wound armature coils, and which are excited by a single field coil concentric with the shaft and located between the two stator rings, a revolving wireless rotor serving to perform the changes in the magnetic circuit necessary to induce an e.m.f. in the stationary armature windings. In converting this machine into a frequency changer it is only necessary to employ one set of the stator windings as a motor armature and the other set as a generator armature, and to make the number of rotor projections which are situated within the generator half of the machine different from the number of projections which revolve within the motor half; the machine thus becomes a motor-generator with a single field winding, separately excited, of course. The windings being stationary, they may be readily connected up in a variety of ways, so that a single machine can be connected to give two-phase or three-phase currents of various voltages. The frequency, of course, cannot be changed without changing the pitch of the armature coils and the rotor extensions or poles.

Frequency changers, as a rule, are employed to change a low frequency into a higher one for lighting service, although, of course, this function may be reversed. The machine here shown is designed to transform 25-cycle three-phase currents of 1800 volts into 50-cycle two-phase currents of either 1125 or 2250 volts, according to the manner of connecting up the generator winding. Fig. 2 is a diagram of the windings, motor connections and generator terminal board and Fig. 3 is a diagrammatic end view of the two stators and the corresponding halves of the rotor. It will be noticed that the half of the rotor in the motor side of the machine has six poles, while the half which revolves in the generator side has 12 poles, and that the pitches of

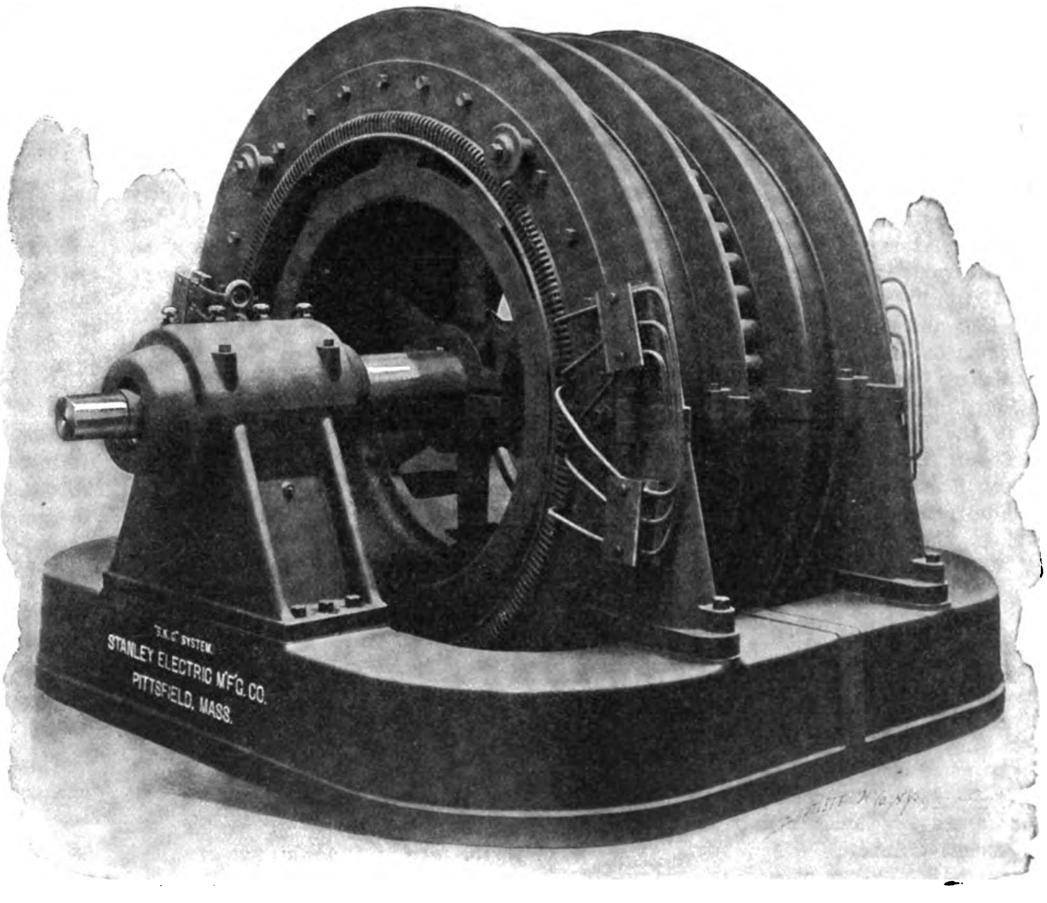


FIG. 1.—S. K. C. FREQUENCY CHANGER.

the stationary coils on the two sides differ correspondingly. The generator side of the machine is provided with a terminal board, the connections of which are shown in the upper part of Fig. 2; the two semi-circular arrangements resembling rheostats are the faces of two inductive voltage regulators, one regulator being inserted in each phase of the generator winding. By this means the e.m.f. of each phase may be regulated independently of the other and also independently of the field excitation. These auxiliary regulators provide a range of 10 per cent variation in the e.m.f. of each phase. In the winding diagram the letters, *A*, *B* and *C* indicate the coils of the three phases of the motor winding, and the figures referring to the generator winding indicate the terminals which are led to the connections on the terminal board which are indicated by the same figures. The motor winding is connected up delta-fashion, as indicated by the diagram in the upper left-hand corner of Fig. 2.

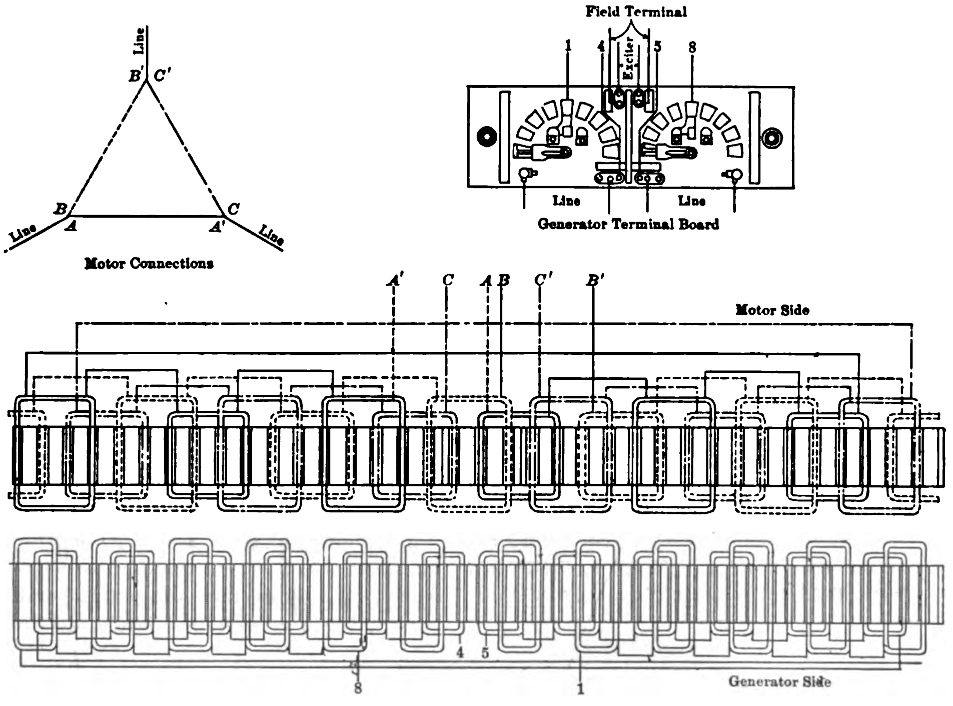


FIG. 2.—DIAGRAM OF WINDINGS, S. K. C. FREQUENCY CHANGER.

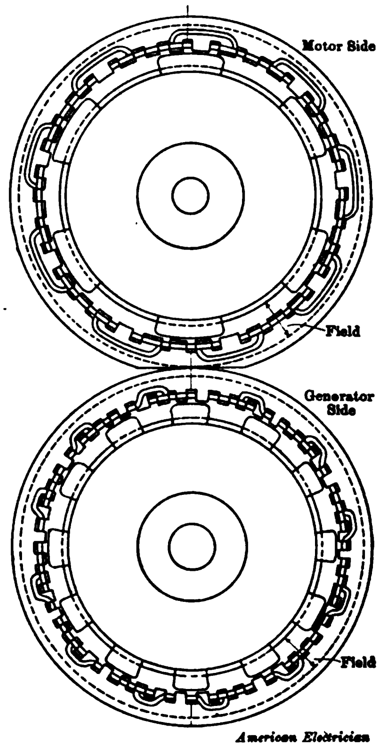


FIG. 3.

* * *

SWITCHBOARD SHUNTS AND TRANSFORMERS FOR ELECTRICAL MEASURING INSTRUMENTS.

A plan has been devised by Machado & Roller, New York, in connection with the instruments of the Whitney Electrical Instrument Company, which is of great convenience to users of shunted instruments. It consists of proportioning all instrument shunts so that the drop between terminals at rated load is the same. and building all ammeters whatever their capacity, so that the same difference of potential in milli-volts will cause the needle of any one of them to swing to full scale. All the ammeters on a given board may therefore be readily compared without interfering with the shunts or bus-bars, by disconnecting the leads of each meter from their several shunts, and supplying them in parallel with current from a single test cell of dry battery; sufficient resistance, of course, being interposed to cut down the voltage to a point where the meters show full scale. If any of the instruments does not show full scale it is evidently out of calibration, by the percentage that the indication bears to the full indication; and the meter must be either run with a correction factor or sent away for adjustment. In such an event it is not necessary to remove the shunt, since the drop it gives across the contact studs is a standard and known quantity.

Where a milli-voltmeter is at hand, a shunt may be readily attached to it and its readings compared with the station instrument, enabling the former to act as a check on the latter and perchance take its place when emergency requires. It is claimed that the shunts themselves will never vary as they are specially made by milling out solid blocks so as to obviate the soldered contacts usually employed and which are sources of possible error. As shown by Fig. 1 herewith, the terminals on the shunts to which the instrument leads are attached, are exceptionally heavy in order that contact errors at that point, which are a source of difficulty with shunted ammeters, may be minimized. Other features of the devices such as the temperature coefficient of the shunt material have been the subject of much thought and investigation and the final form arrived at is said to be conducive to high commercial accuracy.

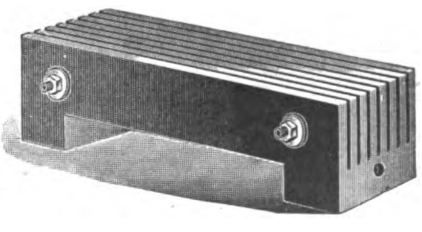


FIG. 1.—SWITCHBOARD SHUNT.

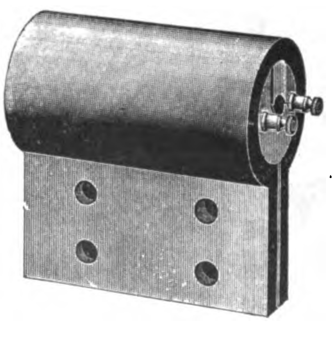


FIG. 2.—TRANSFORMER.

Fig. 2 illustrates a device which serves the same purpose for alternating-current instruments that the shunt-block does on direct current. It is a small transformer having a one-turn primary with very heavy terminals bolted directly to the bus-bar connection. The secondary is wound on a split aluminum spool which fits inside of the primary; in this coil is induced a small current which is carried to the instrument by means of suitable leads. The advantages accruing from the use of this device are of course that heavy conductors need not be carried to and from the instruments and that the secondary potential is almost nil, obviating any possibility of danger from the high voltages usually carried on the main busses. These transformers are made with capacities as high as 15,000 amperes.

New Apparatus and Appliances

ENGINE-LATHE MOTORS.

The accompanying illustration, Fig. 1, shows a Commercial double-commutator motor geared to a heavy engine lathe. By a specially constructed saddle casting, the motor is mounted upon the standard head stock casting, thus requiring no change in the lathe patterns. The motor drives a simple sleeve which replaces the ordinary step pulley or cone in the head stock of a belt-driven lathe. It is of the semi-enclosed type, and is said to be so designed that the greatest torque is secured at the low speeds. By means of various combinations of windings with gearing, 12 different speeds of the spindle are secured, ranging from 2½ r.p.m. to 450 r.p.m., without the use of any external resistance in the armature circuit. When set for a given speed, that speed is maintained practically constant, it is asserted, whether a light or heavy cut is being taken by the lathe tool. The starting and stopping of the lathe is accomplished at the apron of the carriage. The controller is constructed with an interlocking mechanism which is said to make it impossible to form two combinations of circuits simultaneously, or to start the motor without the speed-governing lever being locked in its correct position. The manufacturer claims that by the use of this system of motor propulsion heavier cuts can be made and greater pulling force exerted than can be secured with the ordinary belt-driven lathe, for the reason that the capacity of the latter is limited by the driving power of the belt. In addition to this the use of all belting and shafting is eliminated, the advantages of which are obvious. The motors are built by the Commercial Electric Company, of Indianapolis, Ind.

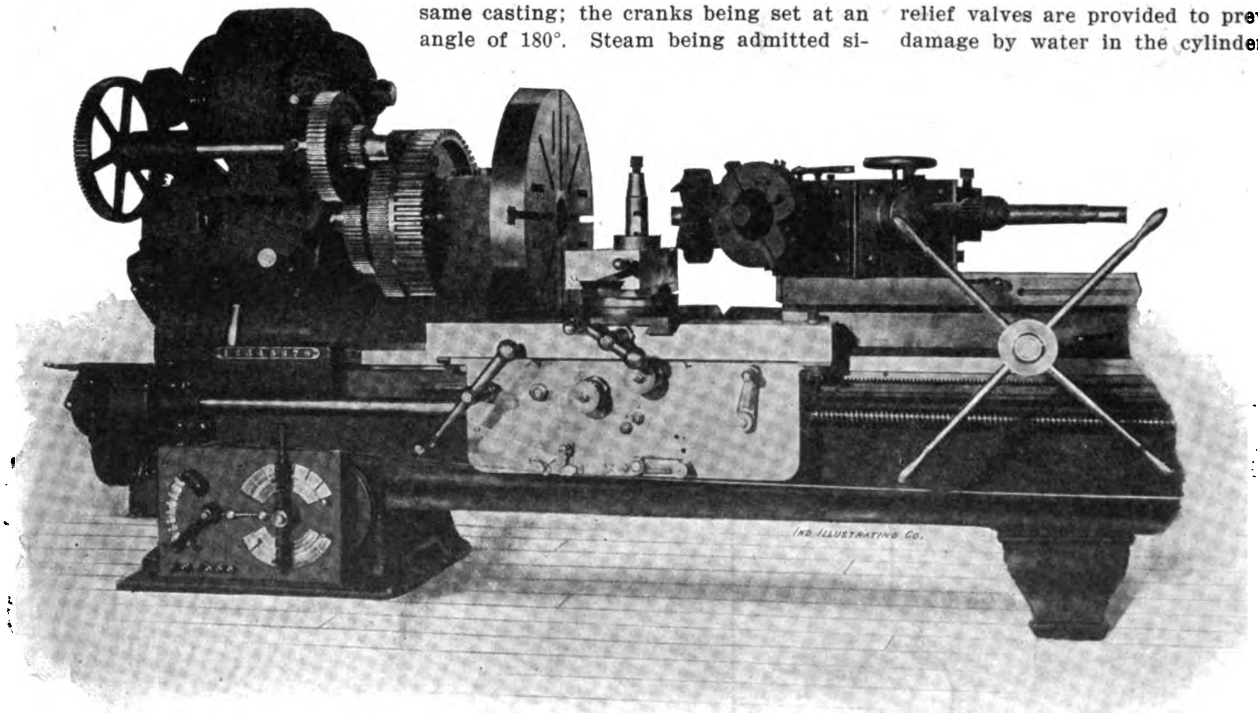


FIG. 1.—MOTOR DRIVEN ENGINE-LATHE.

COMPACT GENERATING SET.

Fig. 2 depicts a 5 x 4-in. enclosed double upright engine and standard 12-kw. 4-pole generator built by the B. F. Sturtevant Company, of Boston, Mass. The engine is of the type originally designed for the work of forced draft fan propulsion on the vessels of the United States navy. The cylinders are placed side by side in the same casting; the cranks being set at an angle of 180°. Steam being admitted simultaneously to the top of one cylinder and the bottom of the other, the reciprocating parts are balanced in their movements and high speed is made possible. The cylinders are of large diameter as compared with the stroke, in order that the power may be developed at high rotative but moderate piston speed. The steam admission to both cylinders is regulated by a single piston valve, under the control of a shaft governor. All moving parts subject to friction are of steel and the bearings of ample size. Automatic relief valves are provided to prevent any damage by water in the cylinder. Complete sight-feed oiling arrangements from a single oil tank connect with all of the bearings, and the frame is so constructed as to enclose all running parts, while still

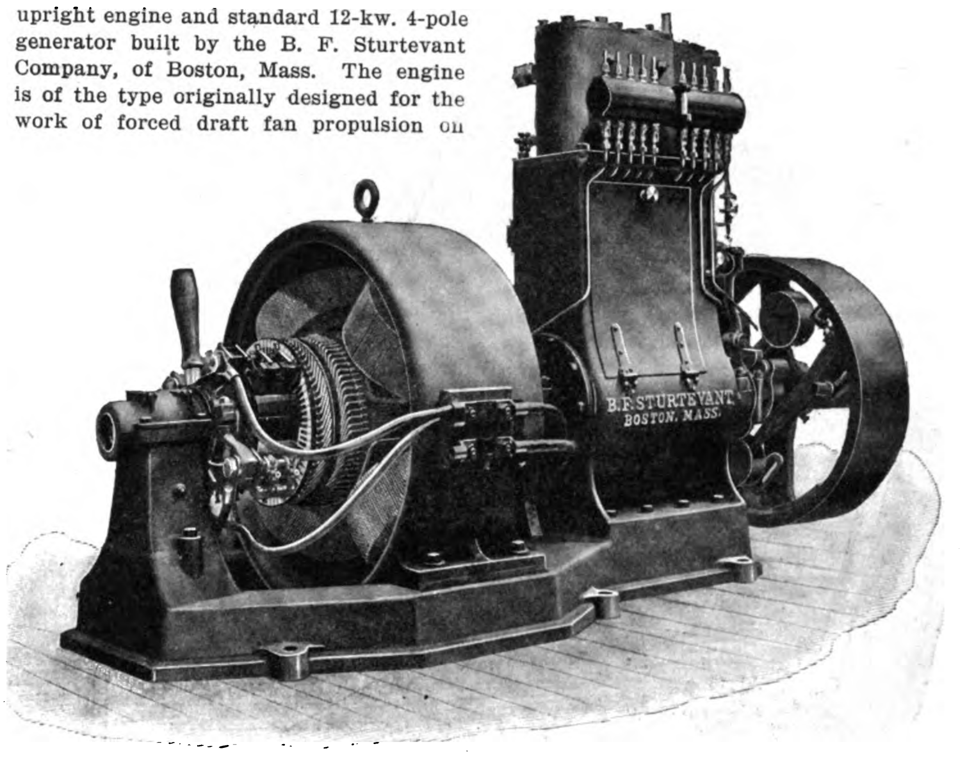


FIG. 2.—DIRECT-COUPLED 12-KW. GENERATOR.

leaving them accessible by opening a door. The magnet frame of the generator is of cast steel, and the shape of the pole-pieces and proportions of magnetic field and armature are said to insure sparkless operation under all changes of load. The armature is of the barrel-wound type. The cast-iron flange, bolted to the armature spider at each end of the core, forms a support for the projecting ends of the coils. Ventilation is effected by the use of specially constructed vanes, forming air ducts between the laminations of the core. Carbon brushes are used exclusively and are mounted in holders of the sliding socket type, arranged for easy adjustment.

ACME PORTABLE TESTING SET.

The latest form of the Queen Acme Portable Testing Set, illustrated herewith, embraces many important changes in construction and detail. An improvement in the construction of the metal blocks of the Wheatstone bridge and rheostat is shown in Fig. 4. Ordinarily the block is held to the rubber plate by the threaded end of the small rod screwed into the block and the threads being liable to oxidation, a poor contact ensues. In the construction used by Queen & Co., Philadelphia, this objectionable feature is overcome by using part of the block itself extended through the rubber plate to take the check nut below. A small rod, to which the end of the wire comprising the resistance coil is soldered, is also soldered into the bottom of the brass block. This gives a complete soldered circuit from the plug contact through one block and rod with its resistance coil, back through the end rod and block, and succeeding plug contact. The bottom of the metal block is also provided with a knurled surface as shown at K, so that the little corrugations will be forced into the rubber plate, securely fastening it, and preventing the block from turning when the plug is inserted.

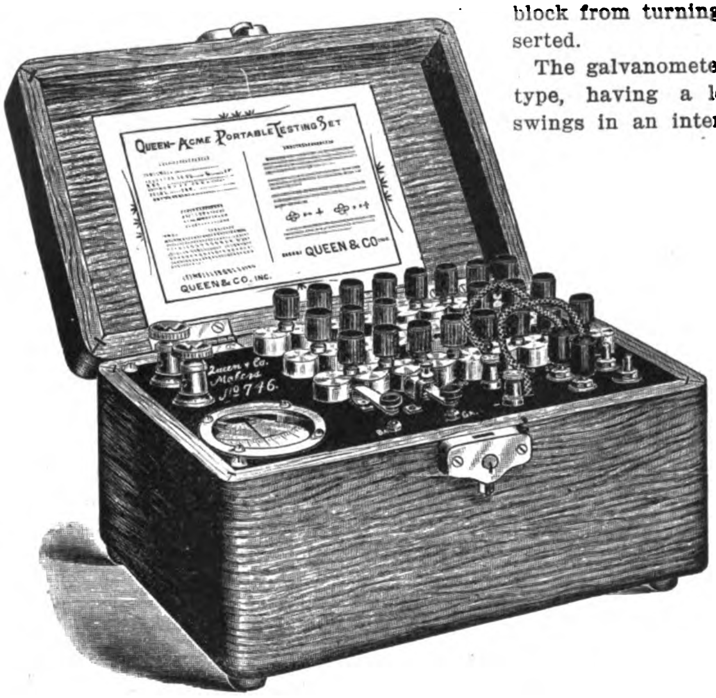

Queen-Acme Portable Testing Set
Queen & Co.
Queen & Co. Inc.
Queen & Co. Makers
No 2746.

FIG. 3.—ACME PORTABLE TESTING OUTFIT.

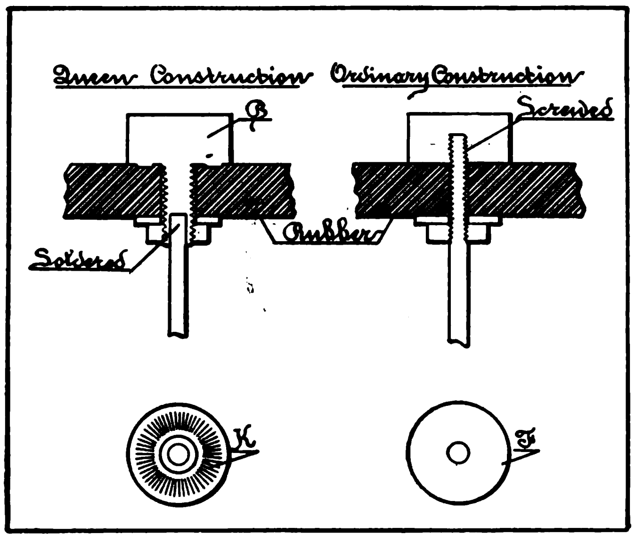


FIG. 4.—DETAILS OF PLUG BLOCKS.

The galvanometer is of the D'Arsonval type, having a long, light coil which swings in an intense magnetic field, resulting in a high degree of sensitiveness. The system is so balanced that the set can be used in any position without impairing the accuracy of the indications. It is deadbeat and has a uniform scale which can be calibrated, so that the instrument can be used in insulation tests, the scale reading representing the insulation resistance. The battery consists of four special dry cells, any or all of which may be used as desired. The batteries have a large current capacity and a high e.m.f. and are said to give better results than the silver chloride cells heretofore used. The makers furnish this set enclosed in a finished oak case, and it is accompanied by a special circular describing the various details of the set and the different measurements which may be made with it.

PRIVATE TELEPHONE SYSTEMS.

The Manhattan Hotel, New York City, is elaborately equipped with labor-saving devices, not the least of which is the telephone system installed by the Lambert-Schmidt Telephone Manufacturing Company of New York City; which consists of wall and desk telephones connected by a common battery system to the 100-drop switchboard shown by Fig. 5. The method of calling is to remove the receiver from the hook, which automatically raises the line drop at the switchboard, this drop staying in that position until the operator

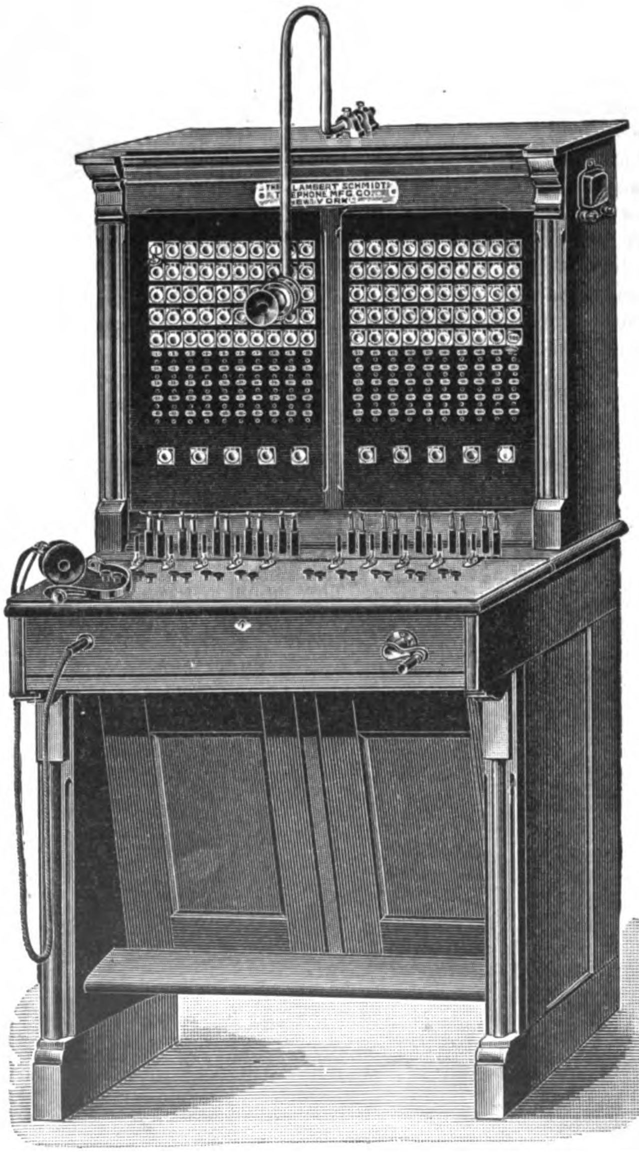

The Lambert Schmidt Telephone Mfg Co. New York

FIG. 5.—100-DROP TELEPHONE SWITCHBOARD.

at the switchboard inserts an answering plug in the proper line jack. The operator then throws down the listening cam, ascertains the connection desired, inserts the calling plug in the jack of the desired number, throws down the ringing key connected with this calling plug and signals the telephone. When through talking, hanging up the receiver at either station raises the clearing-out drop corresponding with the pair of plugs in use and this drop remains in that position until the correct pair of plugs is withdrawn. In the basement is located a battery closet for supplying current for the entire telephone system and an alternating current motor-generator, also in the basement, is used in signalling the telephone stations from the switchboard. The wall telephones consist merely of a transmitter, double-pole receiver, polarized ringer and automatic switch-hook, mounted in a hardwood box. The desk telephones are of the all-metal portable type.

ALCOHOL AND GASOLINE TORCHES.

Figs. 6 and 7 show a torch which the Clayton & Lambert Manufacturing Company has recently added to its line. The company also manufactures an alcohol torch of pocket size, somewhat similar in appearance to the one shown, the tank of which is drawn from heavy brass and is free from seams, having an adjustable blow pipe screwing up or down on the burner tube, together with a screw cap for making the torch air tight when not in use. The torch illustrated by Fig. 7 burns either alcohol or gasoline. An air blast is passed through a chamber charged with gasoline or alcohol, which is said to yield a much stronger fire than the usual type. This torch is also of pocket size, and is provided with a hook so that it may be hung up and used as a lamp when the blow pipe is not used. Both torches are nickel-plated and polished.

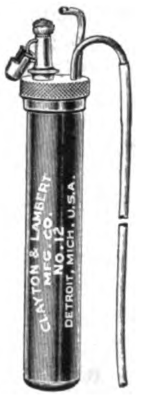


FIG. 6.

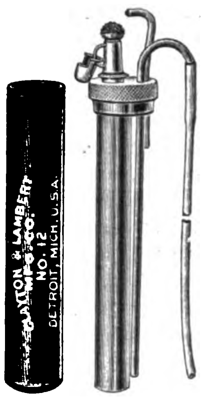


FIG. 7.

ELECTRICALLY-DRIVEN BENDING ROLLS.

The bending rolls illustrated by Fig. 8 are made of solid wrought iron forgings arranged in pyramid form and have a capacity for bending plates up to 12 ft. in width and ⅝ in. thick. The lower rolls are geared together while the upper or bending roll is revolved by the friction of the plate in passing through. It has a hinged bearing at one end which may be turned down out of the way, while the other end has a long shank extending to a third support which retains the roll in position for the removal of rings or flues. The machine is firmly tied together by a heavy cast-iron bed plate, and is very strongly geared. Suitable levers and clutches are conveniently placed for the quick and easy control of all the operations. The rolls are driven by an 18-h.p. reversible, constant-speed motor built by the Bullock Electric Manufacturing Company, of Cincinnati, Ohio. The field magnet consists of a circular yoke of special steel, and pole-pieces built up of soft sheet steel stampings securely bolted to the yoke. The shape of the punchings is said to be such as to produce saturated pole-faces resulting in sparkless commutation. The field coils are machine wound and are slipped over the poles before they are bolted to the yoke. The armature core discs are annealed and then japanned. They are held firmly together by malleable iron end plates. For controlling the motor, an automatic rheostat is used which prevents the operator from throwing on the full current too quickly.

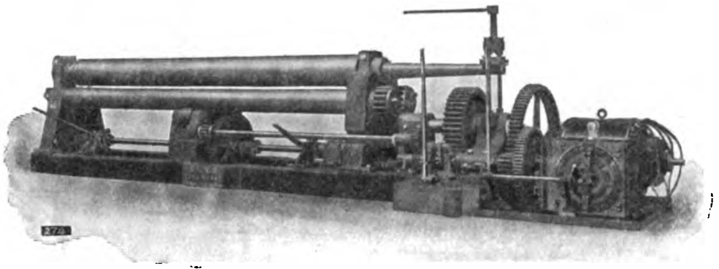


FIG. 8.—MOTOR-DRIVEN BENDING ROLLS.

A NEW ELECTRO-MECHANICAL SWITCH.

Fig. 9 illustrates a substantial electro-mechanical switch recently brought out by the General Incandescent Arc Light Company, New York.

This switch is designed to control a number of electric lights or motors, etc., from one or a number of distant points, without running the heavy mains to the points of control. Essentially the switch consists of a pair of solenoids held firmly in an iron frame, which acts as a return path for the magnetic lines of force and thereby increases the "pull" during the opening or closing of the switch. As the switch begins to move, the pull continually increases in strength until it reaches its maximum at the end of the stroke. This feature is advantageous in closing the switch, as the magnetism has to overcome the fraction of the contacts, and any hesitancy on the part of the switch to continue its motion at this moment would produce excessive arcing and pitting, thereby further hindering the entrance of the switch blades into the clips.

The lower core has a "lost motion" which is first taken up by the solenoid, producing a heavy hammer blow which opens the contacts and is followed by the strong accelerating pull of the magnet until the final position is reached. There is no danger, therefore, of the switch stopping or even hesitating after it has once started to close or open. The contacts are made very flexible so as to avoid danger of their sticking; they are also self-adjusting and give a perfectly flat rubbing surface. It will be seen from the illustration that the current is broken in two places on each pole, making six breaks in a three-pole switch. The illustration shows a 100-ampere three-wire switch such as is used on the Edison three-wire system, but the switches are also made single, double and triple pole for any capacity, voltage or system, either direct or alternating. The switch automatically cuts the solenoids out of circuit after its operation, so that there is no danger of their burning out and there is no arcing at the push-button. Secondary circuit-breaking contacts are provided to take the arc on each one of the contacts, so that the main contacts will not be burned or their temper reduced.

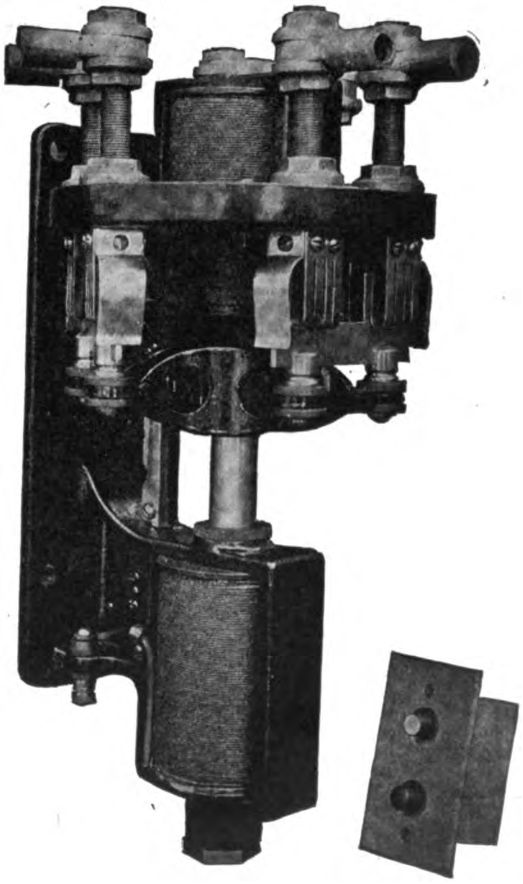


FIG. 9.—ELECTRO-MECHANICAL SWITCH.

As the coils can be wound for any voltage, batteries may be used to operate the switch if it is not desirable to use the lighting circuit for that purpose. The solenoids require from 150 to 200 watts to operate them. This method is often employed when it is desired for any reason to cut the lighting or power service entirely out of the building. The push-button switch is made in a very substantial manner and will fit into any flush receptacle. The buttons are made one black and one white, as usual, so that one may tell at a glance which to press in order to open or close the switch.

HOTEL TELEPHONE EQUIPMENTS.

Telephones have become almost as much of a necessity in model hotels or apartment houses as elevators or mail chutes. For this reason the new Hotel Essex in New York city has been equipped throughout with telephones and a switchboard, giving rapid communication between the office and every suite and hall; and placing the management within easy reach of every patron. The Ericsson Telephone Company, of New York, installed all of the apparatus. The room telephones are all of the hand microtelephone pattern shown by Fig. 12. Each is fitted with a flexible cord sufficiently long to enable a person to use it without rising from the bed. The office is called by pressing a contact in the handle of the microtelephone which throws the drop at the switchboard. The operator connects in the usual manner and if the person desires to converse with a patron in another part of the hotel the connection is made and the operator calls the party desired by ringing a small musical gong placed near the ceiling of the apartment. The halls are furnished with wall telephone sets of the type shown by Fig. 11. The telephone is fitted with the Ericsson receiver and transmitter and the office operator is called by merely removing the receiver from the hook. The switchboard is shown by Fig. 10. It embodies the finest mechanical construction and occupies very little space compared to its capacity. The system is operated by central batteries and is so arranged that when desired, a motor generator can be used instead of the battery for calling.

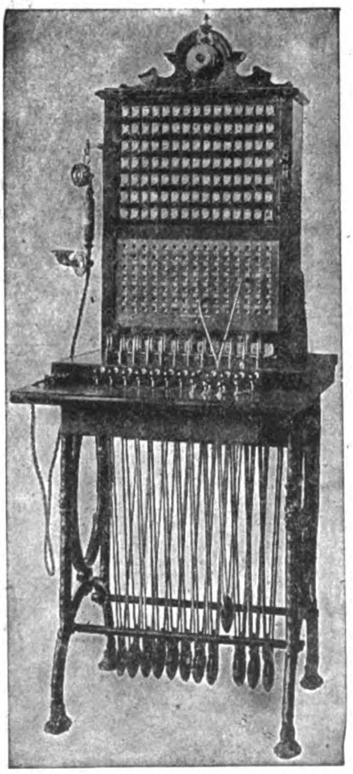


FIG. 10.—TELEPHONE SWITCHBOARD.

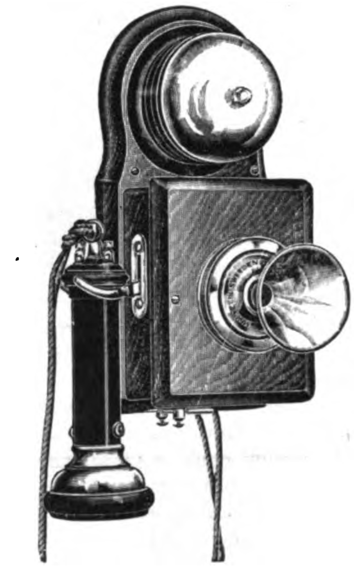


FIG. 11.—WALL TELEPHONE.

INTERRUPTER FOR X-RAY COILS.

A modified Wehnelt interrupter designed jointly by Dr. P. H. Cunningham and Elmer G. Willyoung, of New York, and manufactured by Mr. Willyoung is shown by Fig. 14. It is especially adapted for Roentgen ray coils, and is said to reduce the time of exposure necessary for photographing through the trunk or pelvis to about four minutes. Reversing the connections is said to make a rectifier of it for use in operating induction coils on an alternating current circuit. Its construction is clearly shown by Figs. 13 and 14. A glass jar 9 ins. deep by 6 ins. in diameter rests in a heavy base and carries a hard fiber cover in which are held the anode and cathode. A platinum wire, *P*, is brazed to the end of a brass rod, *R*, and passes through a lava tip, *T*. An adjusting screw, *A*, is provided which serves to expose a greater or less area of platinum beyond the lava tip. All the metal parts are enclosed in a hard rubber tube, *K*, which fits tightly into the central disc of the cover. The lead electrode is insulated in practically the same manner as the platinum although not as readily detachable, it being possible to remove and replace the latter very quickly. A worm of ⅜-in. lead pipe has a current of cold water circulating through it which serves to keep the apparatus cool when in operation. A vent in the cover permits the escape of the generated gas.

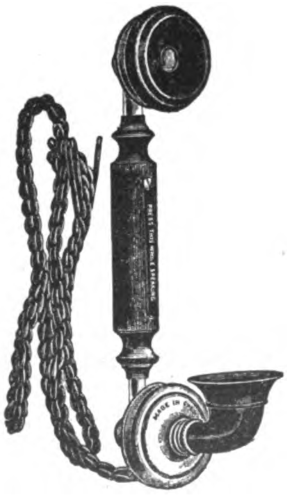


FIG. 12.—MICROTELEPHONE.

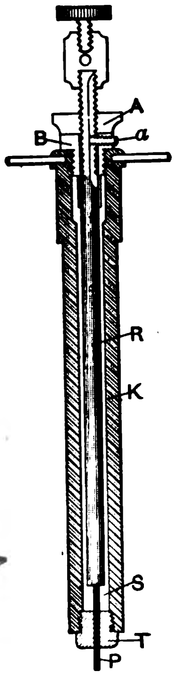


FIG. 13.

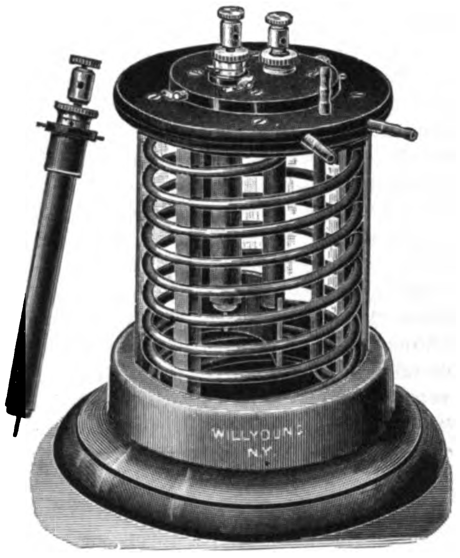


FIG. 14.—THE WEHNELT INTERRUPTER.

AN INSTRUMENT FOR TEACHING TELEGRAPHY.

An instrument designed to simplify instruction in telegraphy and to impart in a comparatively short time a knowledge of the Morse alphabet is illustrated by Fig. 15. The Omnigraph, as this instrument is called, consists of a baseboard on which are mounted an ordinary key and sounder and between them a disc furnished with teeth which are engaged by a spring contact adjacent to the disc. The disc is rotated by means of a small crank shaft geared with the disc shaft, while the spring contact being forced outwardly by the teeth and returning by its own elasticity makes and breaks the circuit, and an experienced telegrapher will immediately recognize in these makes and breaks the

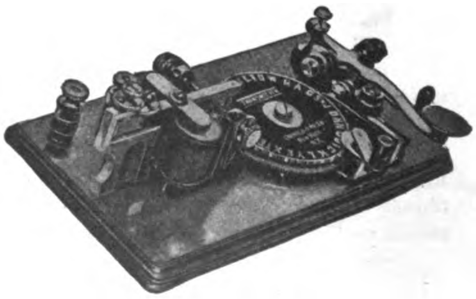


FIG. 15.—THE OMNIGRAPH.

dots and dashes of the Morse alphabet. An inspection of the disc shows that the teeth are arranged to spell the sentence "John quickly extemporized five tow bags" which includes all the letters of the alphabet. This message is transmitted slowly or rapidly and with a distinctness and faultlessness not attainable with the key in ordinary practice. When the student has learned to distinguish the different letters with sufficient proficiency he can learn to transmit messages by the key which forms part of the apparatus. This apparatus is manufactured by the Omnigraph Manufacturing Company, of New York City.

A NEW GATE VALVE.

The accompanying engravings illustrate the principal features of a gate valve made by the Darling Pump & Manufacturing Company, Limited, of Williamsport, Pa. The valve is interchangeable and is said to differ from other gate valves in that it has compound equalizing wedges, parallel seats and double revolving gate discs—three distinct advantages which the manufacturer claims are not embodied in any other single gate valve. The wedging mechanism operates between the gate discs; the discs themselves being capable of revolving independent of each other and of the wedging mechanism. A sectional view of a bronze mounted iron water valve is shown by Fig. 17, in which *A* is a clamp nut; *B*, a bonnet; *D*, a follower; *E*, a packing plate; *G*, gates; *K*, follower bolts; *M*, the upper wedge; *N*, gate rings; *O*, the bottom wedge, and *P*, the case rings. Opposite lateral guides, or grooves (shown by white lines above the part, *G*, Fig. 17), are provided upon which the peripheries of the gate discs roll, either up or down, in or out, in opening or closing the valve. Fig. 16 shows the parts of the wedging mechanism. The upper wedge is provided with a threaded hole to receive the stem, from which it receives motion to raise or lower the gate discs in opening or closing the valve; it is also provided with two lateral rounded bosses, or bearing lugs, upon which fit loosely the bearing sockets in the inner surfaces of the gate discs. The lower wedge hangs loosely upon the boss on one of the gate discs, and is provided with inclined faces co-acting with those upon the upper wedge. The operation of the valve in closing is as follows:

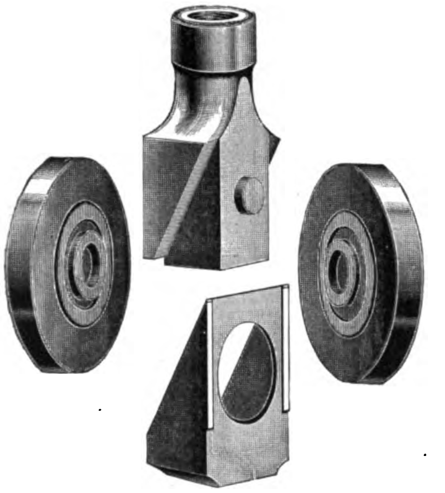


FIG. 16.—DETAILS OF VALVE GATE.

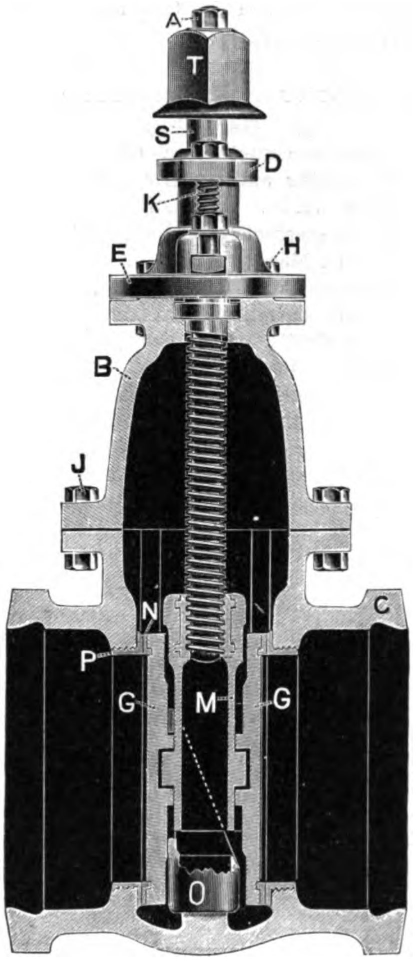


FIG. 17.—SECTION OF GATE VALVE.

The valve being open, the parts hang loosely upon the upper wedge; the wedges are extended or are in alignment and hence the gate discs are arranged with their outer faces at an interval less than the distance between the valve seats. The stem is turned and the parts descend free and clear of the seats until the lower wedge reaches the bottom of the case and its movement is checked; then the gate discs are in proper position opposite the ports or pipe openings of the valve; the further downward movement of the upper wedge causes the inclined surfaces of the upper and lower wedges to slide upon each other and thus contract the wedge block longitudinally and spread it laterally (bringing the pressure to bear over almost the entire surface of the gate discs instead of just on one small part), thereby forcing the gate discs firmly against the seats. In opening the valve a quarter turn is sufficient to release the upper wedge and a further movement of the stem raises the parts free and clear, leaving a straight passage through the valve.

The valves are said to work equally well with pressure on either side of the gates, and each valve is tested before shipment. These valves are at present made in sizes for pipe 2 ins. to 16 ins. diameter; with either hub ends, spigot ends, screw ends or flange ends; either iron body, bronze mounted; or all brass or all iron and for test pressures of 300 lbs. to 2200 lbs., depending upon the service required.

IMPROVED SIGN-LAMP RECEPTACLE.

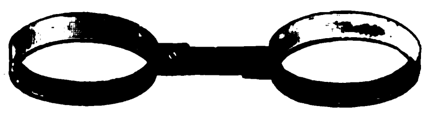


FIG. 19.—CLAMP HOOKS.

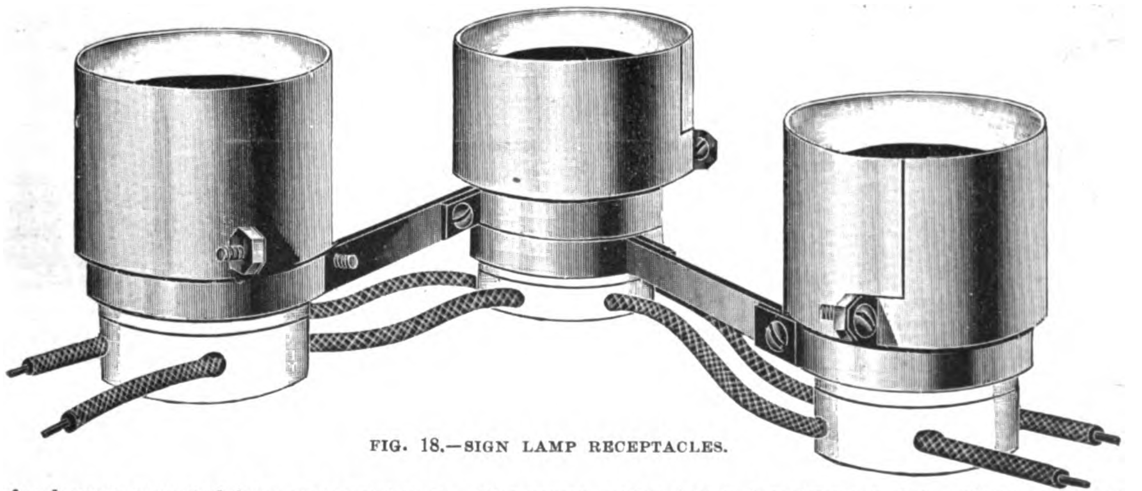


FIG. 18.—SIGN LAMP RECEPTACLES.

Figs. 18 and 19 herewith show the "Brewster universal" sign receptacle made by the Electric Motor & Equipment Company, of Newark, N. J., by means of which it is claimed any form of electrically illuminated sign or decoration for the interior or front of a building may be quickly made up and changed at will at comparatively small expense. The receptacles are linked together by S-shaped clamp hooks which bind firmly about the receptacles, clamping the whole structure into a rigid outline of any design or proportion desired. For in-door use the receptacles may be readily wired, using the contacts projecting at the back of the main receptacle. For out-door use in an exposed position where weatherproof construction is desirable, the wires are run through openings in the contact cap provided for that purpose. The space between the wires and the holes may then be filled in with some waterproof compound, and a thoroughly water-tight and safe construction obtained. As an additional protection to the lamp and socket when used in exposed positions out of doors, a metal guard is provided, which is adjustable upon the projecting shoulder of the receptable and which is said to make a practically water-tight junction between the metal cap and the bulb of the lamp. Fig. 19 shows one of the braces and Fig. 18 illustrates the application of the device.

A NEW TUBE CLEANER.

A novel tube cleaner, which is practically a little engine operated by steam or compressed air, is shown by Figs. 20 and 21 and is manufactured by the Power Specialty Company, of Buffalo, N. Y. At the end of what would be the piston rod of a steam engine is a small iron vibrator which oscillates very rapidly. The apparatus is connected by a steam hose to an adjacent boiler and is then introduced at the front end of the boiler flues to be cleaned. Under a steam pressure of 40 to 50 lbs. the machine makes 800 to 1,000 vibrations a minute, which, while sufficient to loosen and detach the scale, is not violent enough to in any way injure the tube. Fig. 20 shows the operation of the cleaner in a horizontal tubular boiler. With slight variations and the addition of a simple feeding device the cleaner is said to cope successfully with the task of cleaning light or heavy scale from water tube boilers. The vibrator in this case carries a sharp head, the function of which is to cut and shatter the scale as shown in Fig. 21; the cutter is so guarded that the sharp edge cannot make the slightest indentation in the tube. The method of operation also differs in the water-tube boilers in that a feeding device works the cleaner through the tube. This is accomplished by attaching the machine to the end of a pipe as long as the tube to be cleaned, and connecting this pipe with the steam hose. A collar with a removable lip is fitted to the boiler front, and a long screw with a hand wheel slides over the pipe and is fastened to it. The revolving wheel feeds the machine into the tube, the spiral working over the lip in the collar, and four jets of steam eject the broken scale at the open end of the tube as fast as it is detached.

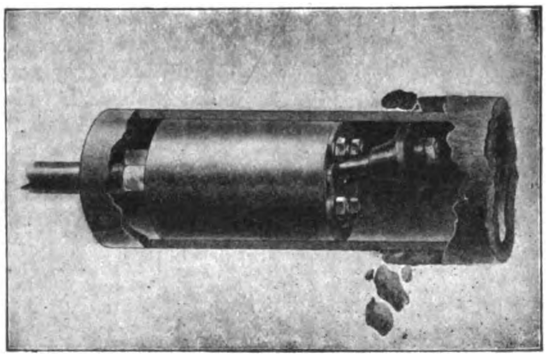


FIG. 20.—CLEANER IN HORIZONTAL TUBULAR BOILER.

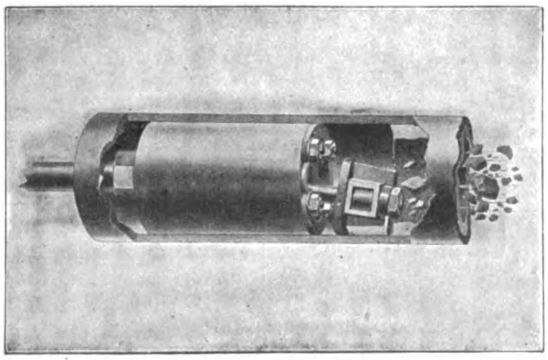


FIG. 21.—CLEANER IN WATER TUBE BOILER.

DIRECT-CONNECTED GENERATOR AND TURBINE.

A notable combination of direct-connected turbine and electric generator is shown by Fig. 24. The plant was installed for the Massachusetts Chemical Company at Walpole, Mass., by the Thresher Electric Company, of Dayton, Ohio, the turbines were furnished by the Stilwell-Bierce & Smith-Valle Company of the same city. Fig. 22 is an outline sketch of the generator and turbine, showing the manner of connecting the shafts of the two. The arrangement of the oil pockets and bearings are shown in Fig. 24, and a full view of the generator is given by Fig. 23. It will be noted that the generator is mounted on top of the turbine, the object being to economize space, and at the same time to obtain the simplest possible mechanical connection between the dynamo and the turbine. The wheel shown operates under 14-ft. head and develops about 115 horse-power, maintaining a speed of 150 r.p.m. It is set in a steel flume having cast-iron heads, and the water is conveyed to the flume by a steel feeder pipe. The flume itself stands on I-beams across the pit, with the usual draft-tube leading from the wheel to the tail water.

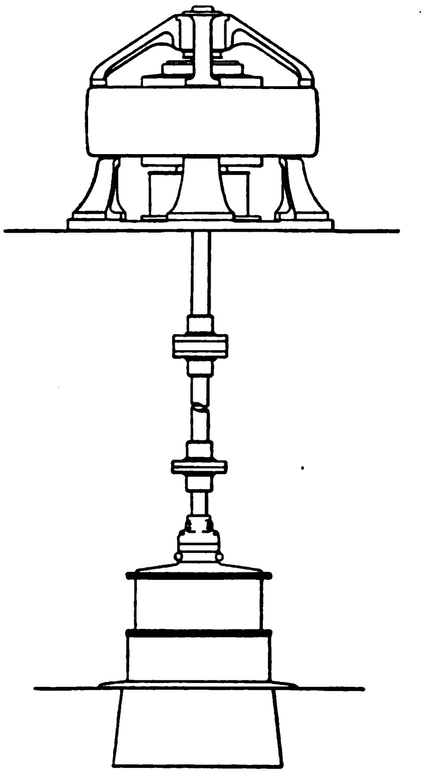
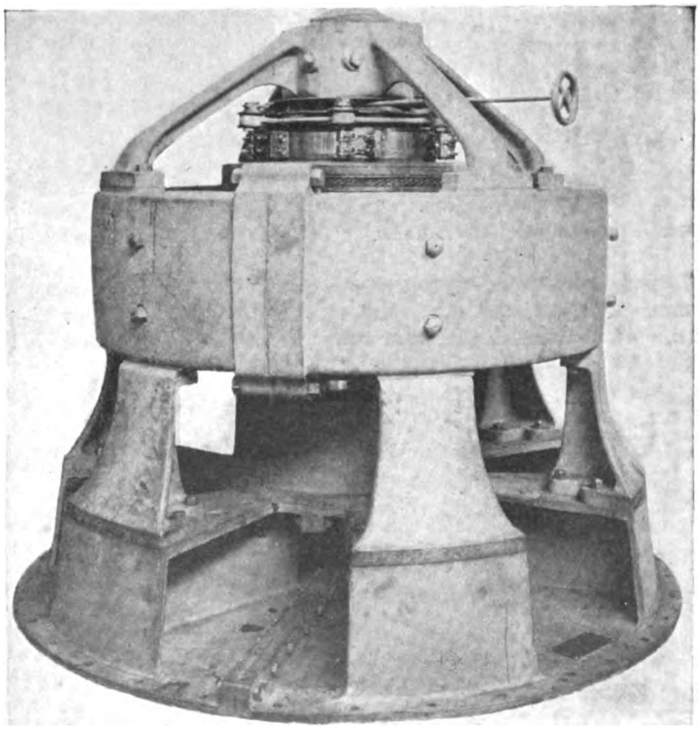


FIG. 22.—ARRANGEMENT OF TURBINE AND GENERATOR.

Certain original features are embodied in the construction, among them a flexible coupling on the shaft between turbine and generator, permitting free longitudinal action and making the machine self-contained and supported separately on its own thrust bearings. These are composed of several annular rings about the shaft,



FIG] 23.—VIEW SHOWING MOUNTING OF GENERATOR.

which bear on a number of babbitted projecting surfaces. The shaft of the turbine may be varied in length, depending upon the head of water, and having the generator either over the penstock or over the head of the tail race, the flexible coupling taking care of any expansion or contraction of the shaft without throwing any compression strains on the turbine shaft. The lower and upper bearing of the generator are overhung, having a heavy umbrella-shaped form projecting into the oil pocket containing the lubricant. An oil bath surrounded by a water jacket encloses the annular rings, and projecting surfaces mentioned above.

The circulating ducts with which the pocket is provided keep the oil in constant circulation, and any excessive heat is dissipated by the surrounding water jacket. The plant is provided with 80-kw. and 125-kw. machines running at 150 and 200 r.p.m., respectively, each giving an e.m.f of 600 volts. The advantages claimed for this method of connection are: First. the moving parts are simpler, and presenting to the whole revolving mechanism less inertia (upon which the regulation largely depends), they respond more quickly and with greater harmony to the controlling device, which is connected to the gates that regulate the turbine. Second, the generators dispense with the racket and vibration produced by gearing from turbines to horizontal generators. Third, there is greater efficiency of transmission. Fourth, the unit is more certainly regulated for speeds of variable loads, and since it takes less space and foundation, no provision is needed for any movement of the commutator along the length of the brushes, since these generators do not need lateral movement of the commutator to produce uniform wear.

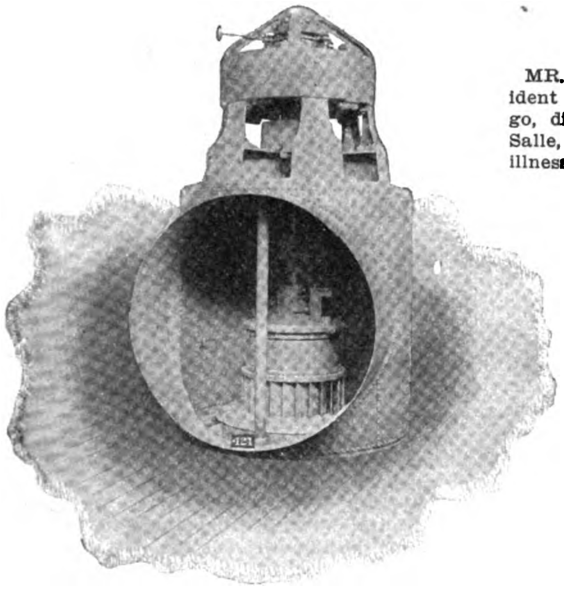


FIG. 24.—DIRECT-CONNECTED GENERATOR AND TURBINE

LEGAL NOTES.

MAGNESIA BOILER AND PIPE COVERING.—The Keasbey & Mattison Company, owners of patents for magnesia boiler and pipe covering, have instituted suit against the Philip Carey Manufacturing Company to restrain this company from making and selling coverings for boilers and steam pipes containing more than 50 per cent of magnesia, and especially such coverings containing 85 per cent of magnesia.

RICE BRUSH-HOLDER.—A preliminary injunction has been granted to the Thomson-Houston Electric Company (General Electric Company) in the suit against the Lorain Steel Company for infringement of the Rice brush-holder patent No. 394,999. The patent covers the combination of a brush follower pressed toward the brush by means of a spring and having an auxiliary spring interposed between the follower and the brush itself.

TROLLEY CONTACT SPRINGS.—Judge Wanty, sitting in the United States Circuit Court of the Western District of Michigan, Southern Division, has given a decision in favor of the General Electric Company in a suit brought by that company against the Starr Brass Works for infringement of the Anderson patent No. 412,155. The patent covers the use of metallic conducting brushes located between the hub of the trolley wheel and the trolley fork, on the inside of the fork.

OBITUARY.

MR. CHARLES SCHLESINGER, vice-president of the Alden Electric Company, Chicago, died at the home of his parents at La Salle, Ills., on March 30, after a prolonged illness.

MR. ULRICH EBERHARDT, president of the company which trades under the style of Gould & Eberhardt, died at his home in Newark, N. J., on March 31. Mr. Eberhardt was born in Switzerland 50 years ago.

HENRY HERBERT LUSCOMB, secretary and superintendent of the Johns-Pratt Company, of Hartford, Conn., and one of the pioneers in the development of trolley-wire insulators and molded insulation, died on April 17, after an illness of only a week. Mr. Luscomb was only 35 years old at the time of his death. He became connected with the Johns-Pratt Company in 1892 when the manufacture of molded insulators for trolley-wire service was in a more or less embryonic condition. At this time the Johns-Pratt Company absorbed the Gould & Watson Company, with which Mr. Luscomb was connected at the time. Mr. Luscomb took charge of one of the departments of the Johns-Pratt Company as foreman, and soon rose to the position of superintendent; he was elected secretary of the company in 1896, which position he held up to the time of his death.

PERSONALS.

MR. ROBERT L. McOUAT, Indianapolis, Ind., was in Chicago last month on a business trip.

MR. V. C. GRAU, formerly connected with Robert L. McOuat, has been appointed western agent for J. Jones & Son, New York, and Queen & Co., of Philadelphia, with headquarters at 934 Monadnock Building Chicago.

MR. H. C. SPALDING has been appointed New England manager for the American Stoker Company, and will be pleased to meet the many friends of himself and his company at the Boston office, 176 Federal Street.

MR. WILLIAM R. HEWITT has been appointed permanent Chief of the Fire Alarm Telegraph system for the city of San Francisco. Mr. Hewitt has been practically the head of the fire alarm and police telegraph system for the past 13 years.

MR. L. E. FRORUP, who has been identified with Schiff, Jordan & Co., has resigned his position with that firm to accept the position of general sales agent for the Falcon Electric Manufacturing Company, New York. Mr. Frorup assumes his new duties on May 1st.

MR. T. B. BOYLES, of the General Electric Company's engineering staff, read a paper on switchboards at the April meeting of the Cleveland Electric Club, which was held April 3. Mr. Boyles was for a long time chief assistant to Mr. E. M. Hewlett, who is the chief engineer of the General Electric Company's switchboard department; the paper, therefore, was authoritative and of high value.

MR. W. S. BARSTOW, general manager of the Edison Electric Illuminating Company, of Brooklyn, and president of the electrical section of the Brooklyn Institute, delivered a lecture last week on the later developments of the twentieth century. Mr. Barstow reviewed in a most interesting manner the recent improvements and inventions, and expressed optimistic views concerning future developments.

MR. STEPHEN L. COLES, for a number of years managing editor of the "Electrical Review," has resigned his connection with that paper to engage in commercial work in the electrical field. Mr. Coles has made a host of friends by reason of his amiable personality and the excellent work which he has done in the newspaper field during the past 10 or 12 years, and will doubtless continue in commercial directions the success which he has achieved in journalistic work.

MR. CHARLES H. DUELL, recent United States Commissioner of Patents, has resigned his position to resume his law practice, and has established headquarters in the St. Paul Building, New York City. Associated with Mr. Duell are Messrs. Wm. A. Megrath, who has been connected with the Patent Office for 15 years, and Frederic P. Warfield, who has been assistant examiner in the Patent Office for several years; these three gentlemen will practice under the firm name of Duell, Megrath and Warfield.

TRADE PUBLICATIONS.

GARTON LIGHTNING ARRESTERS. Garton-Daniels Company, Keokuk, Iowa.—Catalogue No. 24 of the well-known Garton lightning arresters for electric lighting, power and street railway circuits.

CHLORIDE ACCUMULATORS IN MILLS AND FACTORIES. The Electric Storage Battery Company, Philadelphia, Pa.—Bulletin No. 64 describing accumulator installations in textile mills and a coffee and spice establishment.

STANDARD DIRECT-CURRENT CEILING FANS. The Robbins & Myers Company, Springfield, Ohio.—Circulars Nos. 15 and 16, illustrating and describing the well-known Robbins & Myers ceiling fan motors, styles A and B.

INDUCTION MOTORS. General Electric Company.—This is bulletin No. 4248, superseding bulletin No. 4209, and containing illusarations and descriptions of General Electric induction motors with and without starting resistances.

THE AUTOMOTONEER. Garton-Daniels Company, Keokuk, Iowa.—A folder illustrating and describing an arrangement devised for attachment to any of the Type K controllers, the function of which is to prevent "fast feeding" by the motorman.

PELTON WATER WHEELS. Pelton Water Wheel Company, San Francisco, Cal.—This is a preliminary folder containing complete data relating to Pelton water wheels of all sizes from six inches up to six feet in diameter, and for heads ranging from 10 to 1000 ft.

BIPOLAR DYNAMOS AND MOTORS. Thos. P. Benton & Son, La Crosse, Wis.—A pamphlet catalogue illustrating and describing a line of bipolar machines of the well-known Manchester type. These machines are built in sizes ranging from 1¼ to 75 kilowatts.

ELECTRICAL HEATING APPARATUS. American Electrical Heater Company, Detroit, Mich.—Catalogue No. 17, containing illustrations and prices of a complete line of electrical heating apparatus, which includes soldering irons, disc heaters, foot warmers and glue pots.

EXHAUST FAN AND MOTOR OUTFITS. The Emerson Electric Manufacturing Company, St. Louis, Mo.—This is bulletin No. 3029, displacing bulletin No. 3017, and describing the Emerson line of alternating-current and direct-current fan motor equipments for ventilating purposes.

HIGH-VOLTAGE TESTING SETS. Stanley Electric Manufacturing Company, Pittsfield, Mass.—This is bulletin No. 115, describing and illustrating an elaborate arrangement for giving high voltage tests of insulators, insulating materials, etc. The apparatus described gives facilities for making insulation tests up to 120,000 volts.

MICA MINING. Eugene Munsell & Co., New York and Chicago.—This is a handsomely-illustrated pamphlet containing pictures which portray various features of mica mining, including some very interesting photographs of "open cuts," and a picture of the great "Sergeant D" mine in India. Other pictures show Indian laborers cleaning and trimming the mica, and sorting it into packages.

DIRECT-CURRENT VOLTMETERS AND AMMETERS. Thos. P. Benton & Son, La Crosse, Wis.—A folder containing illustrations and price lists of direct-reading voltmeters and ammeters, a feature of which is a wide scale in the neighborhood of the normal running point, the divisions narrowing down at each end of the scale of the voltmeter, and at the starting end of the ammeter scale.

ELECTRIC HEATING APPARATUS. The Simplex Electrical Company, Cambridgeport, Mass.—This is Catalogue No. 6 of electric heating utensils, the character of which ranges from foot-warming pads to street-car heaters, and from boilers to the heaviest laundry irons. The line of cooking utensils includes coffee pots, five o'clock tea sets, griddle-cake discs, chafing dishes and sheet-metal ovens.

THE AUTOSPARKER. Motsinger Device Manufacturing Company, Pendleton, Ind.—This is a compact little catalogue of vest-pocket size, in which is illustrated and described the small dynamo for gas engine ignition which is known as the "autosparker." The feature of this machine is an automatic device which maintains the speed of the dynamo armature practically constant, regardless of variations in the speed of the gas engine fly-wheel from which it is driven.

TELEPHONES AND SWITCHBOARDS. Sun Electric Manufacturing Company, Philadelphia, Pa.—An unusually handsome catalogue of the telephone apparatus manufactured by this well-known company. The catalogue is profusely illustrated, and contains descriptions of the company's entire line. Among other attractive features of its line is the standard toll box telephone for common battery systems, which is arranged so that when the door of the box is opened the relay is connected across the line and automatically shows whether or not the line is busy.

TELEPHONE PAY STATIONS. Baird Manufacturing Company, Chicago, Ill.—A pamphlet devoted to the Baird telephone pay stations, the salient feature of which is a case having a number of slots in the cover, one slot for five-cent pieces, another for tens and so on, and in line with each coin slot, a lever which is pulled forward when the coin is placed in the slot and registers the amount deposited. A rejector is provided which throws out coins deposited in the wrong slot or slugs differing in size from the coin which may be inserted in an attempt to cheat the machine.

PUMPING MACHINERY. The Stilwell-Bierce & Smith-Vaile Company, Dayton, Ohio.—This is catalogue No. 22, containing illustrations and data relating to Smith-Vaile duplex boiler-feed pumps, of both the outside-packed and ordinary types; pressure pumps, pumping engines, marine feed pumps, triplex pumps, pumps for handling viscous and semi-fluids, such as sugar-house product, tar, wet cement, etc., combined air pumps and jet condensers, pumps and surface condensers, etc. The catalogue is handsomely illustrated and contains a considerable amount of general information which is of value to pump users.

INTERIOR TELEPHONES. The Simplex Interior Telephone Company, Cincinnati, Ohio.—A vest-pocket catalogue of interior telephones and auxiliary apparatus. Prominent in this line is an extremely convenient telephone outfit for apartment houses comprising a telephone switchboard to be mounted in the hallway and telephone equipments in each of the apartments. The switchboard consists of a simple arrangement of push buttons, one under each name plate, together with a telephone transmitter and receiver mounted in the center of the board. The arrangement is designed to displace the crude speaking tube outfit which is now extensively used for this class of service.

BUSINESS NEWS.

E. B. LATHAM & CO., New York, have removed their headquarters from 136 Liberty Street to 39 Vesey Street.

KNICKERBOCKER TELEPHONE & TELEGRAPH COMPANY, New York, has removed its general offices from 418 Broome Street to 100 Broadway.

C. O. MAILLOUX, the well-known consulting electrical engineer, has removed his offices from the American Tract Society Building to 76 William Street, New York.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, reports that another Cross oil filter has been added to the equipment of the Hoover, Owens & Rentschler Company, of Hamilton, Ohio, manufacturers of the well-known Hamilton-Corliss engines.

THE CLING-SURFACE MANUFACTURING COMPANY, Syracuse, N. Y., will have a working exhibit in the belting section of the Machinery Building at the Pan-American Exposition showing belts treated with Cling-Surface running slack beside untreated belts running tight.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., has been appointed sales agent for the Hylo baby filament lamp, which was described in the December number of the American Electrician. The company carries a large stock of line construction material, and is able to make prompt shipments.

THE FARR TELEPHONE & CONSTRUCTION SUPPLY COMPANY, Chicago, has found its quarters at 357 Dearborn Street too small and cramped to fill the demands of its business, and has consequently moved into larger quarters at 118-120 Jackson Boulevard, on the ground floor of the Electrical Building.

AN IMPORTANT COMBINATION.—The Bullock Electric Manufacturing Company, of Cincinnati, and the Wagner Electric Manufacturing Company, of St. Louis, have effected a combination of their selling organizations under the management of Mr. E. H. Abadie, formerly sales manager of the Wagner Company.

THE STANDARD AUTOMATIC GAS ENGINE COMPANY, of Oil City, Pa., has received an order from the Tintern-Manor Water Company, of Red Bank, N. J., for four double-acting tandem gas engines of 300 horse-power each, which will be furnished under an economy guarantee of 1 lb. of coal per brake horse-power-hour.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., has opened a branch office at 403 Fisher Building, Chicago, in charge of Mr. C. H. Norwood. For the convenience of eastern customers the company is carrying a stock of standard apparatus at its Westfield (N. J.) factory, and at its eastern office, 136 Liberty Street, New York.

J. H. BUNNELL & CO., of New York City, are rapidly completing the equipment of their new factory, which will have a much larger floor space and greater facilities in the way

A COMMUTATOR NECESSITY.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.

50c. per Stick. $5.00 per Dozen.

For Sale by all Supply Houses.

Upon receipt of this coupon we will send FREE, sample stick.

Name...
Address..
A. E.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO.

of modern machinery than were contained in the Canal Street factory which was recently burned. The new factory will doubtless be completed and in full operation by the time this number of the American Electrician is issued.

JAMES McCREA & CO., manufacturers of steam specialties, have removed their headquarters from 11 and 13 South Canal Street, Chicago, to 67 West Washington Street, where they have a manufacturing floor space of about 5000 sq. ft., and a commodious office space. The firm's business for each month of the present year so far has been double the amount of business for the same months of last year.

THE HAINES & NOYES COMPANY, Chicago, manufacturer of high-grade telephone apparatus, has consolidated its sales department and factory at 118-132 West Jackson Boulevard and is prepared to fill all orders, large and small, promptly. The increased space will permit the company to manufacture telephone apparatus in larger quantities, and a large stock will be carried on hand at all times.

ELMER G. WILLYOUNG, New York City, has been compelled by growth of business to remove his headquarters from 112 Fulton Street to 11 Frankfort Street. At the new place Mr. Willyoung will have something over 1500 sq. ft. of space available for offices and draughting room, and ample space for a private testing laboratory which is being equipped with the latest types of instruments for making electrical measurements.

THE AMERICAN DISTRICT STEAM COMPANY, of Lockport, N. Y., is erecting five large buildings at its new manufacturing plant at North Tonawanda, N. Y. The company during the past three years has been unable to supply the demands made upon it for the construction of underground district steam heating systems, and is increasing its facilities in view of the amount of work now coming in and the large increase which is expected.

SPIES ELECTRIC COMPANY.—The firm of Spies & Co., Chicago, manufacturer of electrical specialties, has changed its name to the Spies Electric Company in order to avoid confusion with other firms doing business under a somewhat similar name. The company will continue at the old address, and has added to its line of work the manufacture of the entire line of bells and buzzers known to the trade as "bug-proof," under license from the Western Bell Works.

THE H. C. ROBERTS ELECTRICAL SUPPLY COMPANY, Philadelphia, Pa., has been compelled to increase its facilities in order to take care of its flourishing business in electrical specialties, and has accordingly leased a four-story store house. The company has just issued its usual monthly calendar blotter, which is fully up to the standard of the previous artistic efforts in this direction. The company has recently added to its already extensive list of good agencies the Gutmann watt-meter.

THE VILTER MANUFACTURING COMPANY, Milwaukee, Wis., reports among other recent important sales the following: J. P. Suberveille, New Iberia, La., three 15 x 36 Corliss engines; Plymouth Refrigerating, Water, Light & Power Company, Plymouth, Wis., one 30 x 20 Corliss engine; Standard Manufacturing Company, Appleton, Wis., one 13 x 20 Corliss engine; Dorschel, Schultz & Co., Chilton, Wis., one 12 x 30 Corliss engine; and Wm. Jacobs, South Bethlehem, Pa., one 10 x 30 Corliss engine.

FRINK REFLECTORS.—The merits of the Frink special patent window reflectors are well known throughout electric lighting circles, and we note with interest that these reflectors are not only used in some of the finest department stores in this country but are rapidly gaining in favor abroad. I. P. Frink, of New York, the manufacturer, reports that these reflectors are in use in the large department store of Tomas Mendirichaga, Monterey, Mexico, and that a large order has been received for the equipment of the show windows of one of the best-known stores in Dublin, Ireland.

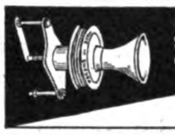
LUNDELL MOTORS AT THE EXPOSITION.—Visitors to the Pan-American Exposition at Buffalo will be able to see the practical operation of Lundell motors in connection with printing presses and other machines used in the allied trades. Among other exhibits will be one of the John Thomson Press Company, whose job presses will be operated by a Lundell 10-hp. round-type motor; R. Hoe & Co. will drive all of their electrotyping machines by Lundell motors, and the Dexter Folder Company will have several machines and a Scott printing press operated by a Lundell motor.

THE LAMBERT SCHMIDT TELEPHONE MANUFACTURING COMPANY, New York, has just secured a contract for equipping the Majestic Hotel with a 400-drop switchboard equipment, this installation being the largest of its kind in New York. The common battery system will be used. The company has recently installed this same system in a number of factories, among these equipments being a 30-drop outfit in the Keuffel & Esser Company's factory, Hoboken, N. J.; a 30-drop equipment for Lehn & Fink, New York; and similar outfits for the Fulton Foundry & Machinery Works, Brooklyn, N. Y., and many others.

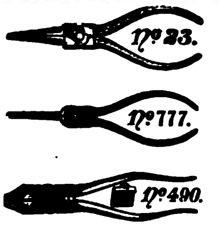
THE STURTEVANT FIRE.—The fire at the works of the B. F. Sturtevant Company, Jamaica Plain, Mass., on April 14, proved to be far less disastrous than was first reported. Only the engine and electrical departments were injured. The power plant was started up with but a single day's delay incident to renewing belts damaged by fire, and the en-

9010-Cortlandt
9000-Harlem
9040-38th St.
are the call numbers of the
Contract offices of the
New York Telephone Company
Calls for these numbers from any Manhattan Station are FREE.
Information regarding telephone service and rates cheerfully furnished.
NEW YORK TELEPHONE COMPANY,
15 Dey Street.
215 West 125th St. 111 West 38th St.

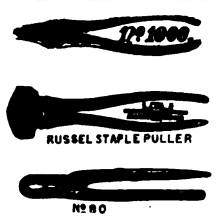
BIG STICK, 35 CENTS.
Sample Free.
SOUTHWORTH & HARE,
Indianapolis, Ind.



GENUINE ERICSSON SWEDISH COAL-GRAIN.
MICROPHONE
THE PERFECT TRANSMITTER.
No Packing. No Adjusting. No Trouble.- Also Complete Line Long Distance Telephones.
Ericsson Telephone Company, 296 Broadway, N.Y.


No. 23.
No. 777.
No. 490.

Is the Best Too Good for You?
If not, get your Nippers and Plyers from a reliable company and see that they bear the name of
UTICA DROP FORGE & TOOL CO.,
SMITH & HEMENWAY CO.,
296 Broadway, New York.



CREAM FLUX.
An Absolutely Non-Corrosive Insulating Soldering Flux FOR ALL METALS. Contains no Acid or Any Element Injurious to Electrical Connections. We guarantee it, and if not satisfactory, money will be refunded. You can make more than double the number of perfect connections in one-half the time with CREAM FLUX than you can with the same amount of any other flux.
PUT UP IN CANS AT 15c., 25c., 45c. and 75c.
SEND FOR TRIAL BOX. SPECIAL PRICES IN QUANTITY.
THIS IS WHAT ONE USER HAS TO SAY: "After having tried the various soldering salts on the market, and after giving your CREAM FLUX severe tests on heavy cable connections, and on the finest stranded flexible drop cord work, we can safely say it meets all claims you make for it. I consider it one of the best ever offered for sale.
Yours truly, CHICAGO EDISON CO., Per J. H. Gobast, Constr. Supt."
Endorsed by the National Board of Fire Underwriters and all users.
FOR SALE BY ALL SUPPLY HOUSES OR
CREAM FLUX CO., SOLE MANUFACTURERS, 909-100 Washington St., CHICAGO

An INCANDESCENT LAMP represents a large investment of cap'tal, ingenuity and skilled workmanship, it is sold at a price so low as to necessitate eternal vigilance in cutting costs to a minimum. A successful lamp manufacturer can not afford to experiment with poor materials. This explains the popularity of
BAKER & CO.'S PLATINUM
408 N. J. R. R. Ave., NEWARK, N. J. 120 LIBERTY ST., NEW YORK
We buy and Refine Platinum Scrap also

tire blower, heater, forge, galvanized iron and shipping departments with the foundry and pattern shop were in full operation on that day and shipments were going forward as usual. New offices were established on Monday morning in a nearby building and on Monday noon the business was running as usual.

THE COMMERCIAL ELECTRIC COMPANY, of Indianapolis, Ind., demonstrates its faith in the efficacy of electrically-driven machine tools by using in its own works a number of heavy engine lathes equipped with Commercial motors. These motors are built to give three speeds, and these combined with a simple system of gearing give the lathe head-stocks 12 speeds, varying from 2½ r.p.m. to 450 r.p.m. A feature of the motor control is that the three speeds are obtained without the use of any external resistance. The company is building a new pattern shop, and contemplates other extensions and improvements in this plant during the coming year.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, has acquired control of 15 acres of land directly opposite the present plant at East Norwood, Ohio, upon which tract the Norwood Foundry Company will erect a foundry building 200 feet long by 150 feet in width; a pattern storage house of fire-proof construction, 50 x 150 feet, three stories high; and a modern office structure. All these buildings will be built of buff pressed brick with steel frames and trusses to conform to the present buildings of the Bullock Electric Manufacturing Company. The foundry will be equipped with three electric cranes, the largest of which will have a capacity of 50 tons. The side bays, which will be 25 feet in width, will be served by hand traveling and jib cranes. This foundry, though separately operated, will primarily serve the needs of the Bullock Company.

LUNDELL DYNAMOS AND MOTORS.—The new large machine shops being erected at Elizabethport, N. J., for the Central Railroad of New Jersey, will be equipped exclusively with the well-known Lundell dynamos and motors by the Sprague Electric Company. The equipment will consist of three 100 kw. generators of 240 volts, to be direct-driven at 250 r.p.m. by Ball & Wood engines, and 75 motors of various sizes for driving the machine tools. In Government work Lundell motors and generators are used to a very large extent. Recent orders include seventeen motors of various sizes for the Norfolk Navy Yard; three 35-hp. motors for the Mare Island Navy Yard; four motors for the Boston Navy Yard, to be used on metal working machines, and five motors, one generator and a 2-kw. ventilating set for the Brooklyn Navy Yard. In addition to the Government orders, the Sprague Company reports the following sales: Steelton Light & Power Company, one 125-kw. belted generator; Columbia University, three 75-kw. engine-type generators; C. S. Ashley, one 125-kw. generator; Pittsburg Reduction Company, one 25-hp. and one 166 hp. motors; National Meter Company, one 37½-kw. engine-type generator; Chase Rolling Mill Company, one 125-kw. belted generator, and the Evansville Gas & Electric Company, one 150-kw. generator.

THE THRESHER ELECTRIC COMPANY, of Dayton, Ohio, has been incorporated under the laws of the State of West Virginia, with an authorized capital of six hundred thousand dollars ($600,000), for the manufacture and sale of all kinds of electrical machinery and appliances. This corporation succeeds the company of the same name of which Mr. Alfred A. Thresher has been the sole proprietor, and which he has incorporated for the purpose of providing more ample facilities for conducting the large and growing business which has been built up during the past eight years under his individual management. The company offers a complete line of direct-current apparatus for electric railways, lighting and power transmission, comprising generators, both direct-connected and belted, of the most approved design, exact in regulation at all points of load and economical in operation; a complete system of motors adapted to the varied requirements of industrial uses, including an entirely enclosed type said to have a very high efficiency, and marine generating sets of highest efficiency, designed to meet the severe requirements of the Government naval service. Plans are being prepared for extensive shops with a complete equipment, affording thoroughly modern facilities for manufacturing and testing.

Mr. Alfred A. Thresher, who is the dominant spirit of the enterprise, is a member of the American Institute of Electrical Engineers, of the Franklin Institute of Philadelphia, an associate member of the Society of Naval Architects and Marine Engineers, and a graduate of Denison University, where he obtained the thorough grounding in the principles of higher mathematics essential to the education of an electrical engineer. After graduation he spent more than a year abroad in travel and observation, and soon after his return established the business which he has brought to such successful fruition.

PRATT INSTITUTE
BROOKLYN, N. Y.
TWO YEAR COURSES IN
Applied Electricity
AND IN
Steam and Machine Design
Write for Catalogue and Particulars.

SOLID TRAINS TO NORTHERN MICHIGAN.

The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

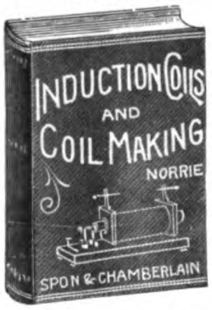
All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

Pan-American Exposition Souvenirs

The latest and most perfected up-to-date Electric Specialties and Novelties, Including Electric Candles, Clock Stands, Scarf Pins, Flash Lights, Etc.

Enclose Stamp for Catalogue

E. J. Tardie & Co.,
221 Sixth Avenue,
NEW YORK.

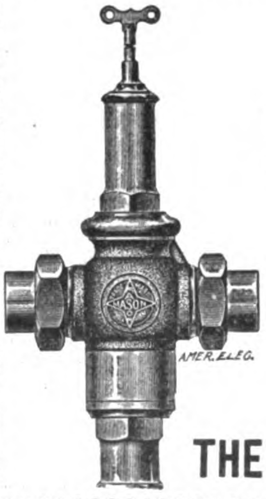


PRICE $1.00.

JUST OUT.

New edition thoroughly revised and brought up to
Latest American Practice
Induction COILS.
By H. S. Norrie.
How to Make Use and Repair Them.
Including Ruhmkorff, Tesla, Medical, Gas Engine and Spark Coils for all purposes.
Nearly 300 pages, fully illustrated, with many original diagrams.

CLOTH, $1.00.
SPON & CHAMBERLAIN, Publishers,
12 Cortlandt St., New York.



THE MASON Reducing Valves
ARE THE WORLD'S STANDARD VALVES

For automatically reducing and absolutely maintaining an even steam or air pressure.

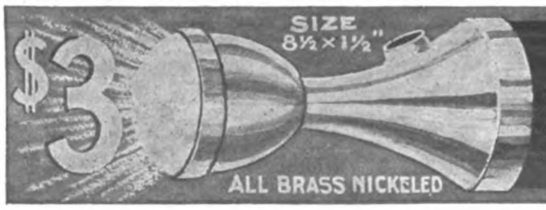
They are adapted for every need and guaranteed to work perfectly in every instance.

WRITE FOR FULL INFORMATION AND SPLENDID REFERENCES.

THE MASON REGULATOR CO., Boston, MASS., U. S. A.

$12.00 per 1-2 Doz.
INCLUDING NICKEL DISPLAY STAND.

Extra Batteries, wholesale, 25 cts. Will keep in stock 3 months. Sample to dealers prepaid on receipt of $2.00.



COMEAD SEARCH LIGHT.

You can pick it up at any time and by simply pressing the button light up any object within fifty feet. Each battery can be used several hundred times. New batteries 35c. Easily inserted. If your dealer does not carry it, send $3.00 to
COMEAD MFG. CO., Buffalo, N. Y.

American Electrician.

Vol. XIII. New York, June, 1901. No. 6.

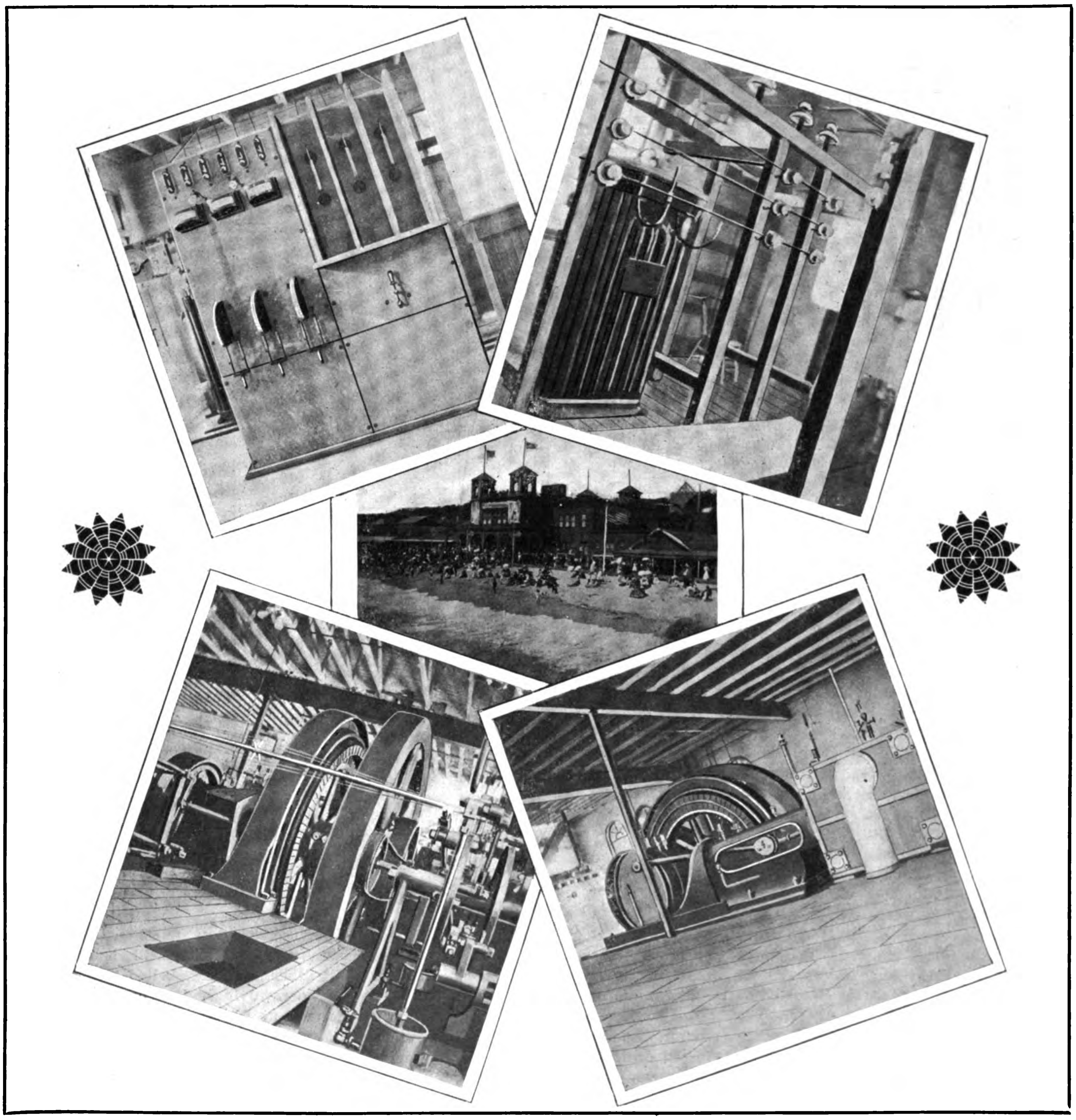
A STEAM-DRIVEN ELECTRICAL TRANSMISSION PLANT.

THE 22,000-VOLT SYSTEM OF THE UNITED ELECTRIC, GAS & POWER COMPANY AT SANTA MONICA, CALIFORNIA.

BY J. R. CRAVATH.

The plant of the United Electric, Gas & Power Company at Santa Monica, Cal., should be of considerable interest to owners and operators of small electric light stations because it offers a suggestion of what may be done in many other localities where several small electric lighting stations are within transmitting distance of one another. The generating station at Santa Monica is an economical steam plant which supplies electric lighting service at Santa Monica and also transmits current at 22,000 volts to electric light sub-stations at Long Beach, Terminal Island, San Pedro and Redondo. These sub-stations displaced small steam plants previously operated. The saving in fuel and labor is roughly 50 per cent as compared with the small plants previously operated.

The power house is located on the famous Santa Monica beach and adjoins the North Beach Bath House, to which it sells the warm salt water discharged from its condensers for the purpose of supply-



FIGS. 1 TO 4.—VIEWS IN THE SANTA MONICA STATION AND SUB-STATION.

ing the swimming tanks. It also supplies both heat and light to the Arcadia Hotel close at hand. The power station is on the beach just under the edge of the bluff. Condensing water is taken from the ocean through a pipe running out on the pier. The general plan of the power house and arrangement of machinery are shown in Figs. 5, 6 and 7. It was designed and built by Chas. C. Moore & Co., of San Francisco.

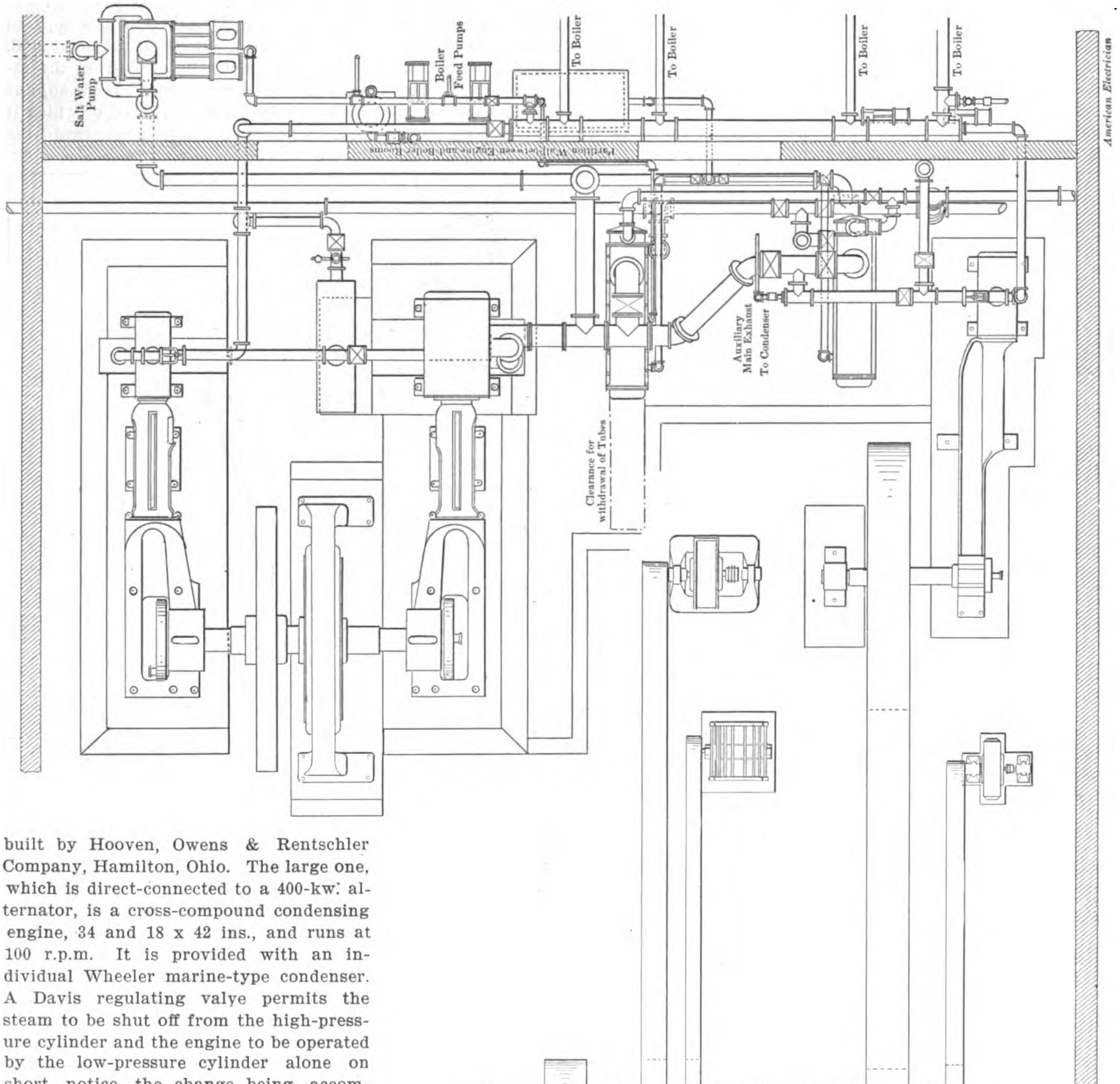

Salt Water Pump
Boiler Feed Pumps
To Boiler
To Boiler
To Boiler
To Boiler
Partition Wall between Engine and Boiler Rooms
Auxiliary Main Exhaust To Condenser
Clearance for withdrawal of Tubes
American Electrician

FIG. 5.—PLAN OF SANTA MONICA ENGINE-ROOM, AND END OF BOILER ROOM.

There are two Hamilton-Corliss engines, built by Hooven, Owens & Rentschler Company, Hamilton, Ohio. The large one, which is direct-connected to a 400-kw. alternator, is a cross-compound condensing engine, 34 and 18 x 42 ins., and runs at 100 r.p.m. It is provided with an individual Wheeler marine-type condenser. A Davis regulating valve permits the steam to be shut off from the high-pressure cylinder and the engine to be operated by the low-pressure cylinder alone on short notice, the change being accomplished by the movement of a single valve handle. As mentioned before, the condenser discharges into the swimming tank of the bath house adjoining. If the water in the tank becomes too warm a by-pass is used. The baths have a capacity of 150,000 gallons. The Arcadia Hotel baths are also supplied with salt water. The steam heating of the Arcadia Hotel is supplied with live steam through a Davis reducing valve. A Blake automatic relief valve is provided to open the exhaust to the atmosphere in case of accident.

The condensed water delivered by the air pump is discharged into a combined hot well and separator shown at the extreme left in Fig. 9, and the cylinder oil is extracted from it by passing the water through straw. The two boiler feed pumps shown in Fig. 9 are 5-in. stroke with 5½-in. steam and 2¾-in. water cylinders, made by the Laidlaw, Dunn, Gordon Company. They pump the feed water from the hot well through a Goubert heater, supplied from the exhaust of the pumps, and then through Green economizers which are placed near the base of the stack at one end of the boiler room. The economizer scrapers are driven by a two-horse-power three-phase induction motor. The stack is only 35 ft. high and forced draft is afforded by either one of two steam-driven 90-in. fans running at 300 r.p.m. maximum; these were built by the Buffalo Forge Company.

The boilers are Babcock & Wilcox, one of 400 horse-power and three of 200 horse-power rating. As in all steam plants in Southern California, crude oil is burned for fuel. This oil is obtained nearby and has an asphalt base. It is very thick and viscous and has to be warmed before it can be successfully used in an oil burner. Fig. 11 shows the boiler fronts and piping to the oil burners. Chapman high-grade valves are used on the entire plant.

There are two three-phase General Electric generators, one a 400-kw. direct-connected, revolving-field machine and the other a 200-kw. belted machine, also of the revolving-field type. Both deliver current at 60 cycles and 2,200 volts, at which e.m.f. current is distributed throughout Santa Monica to transformers for lighting service. The main switchboard, Fig. 8, has a generator panel on each end and three feeder panels between.

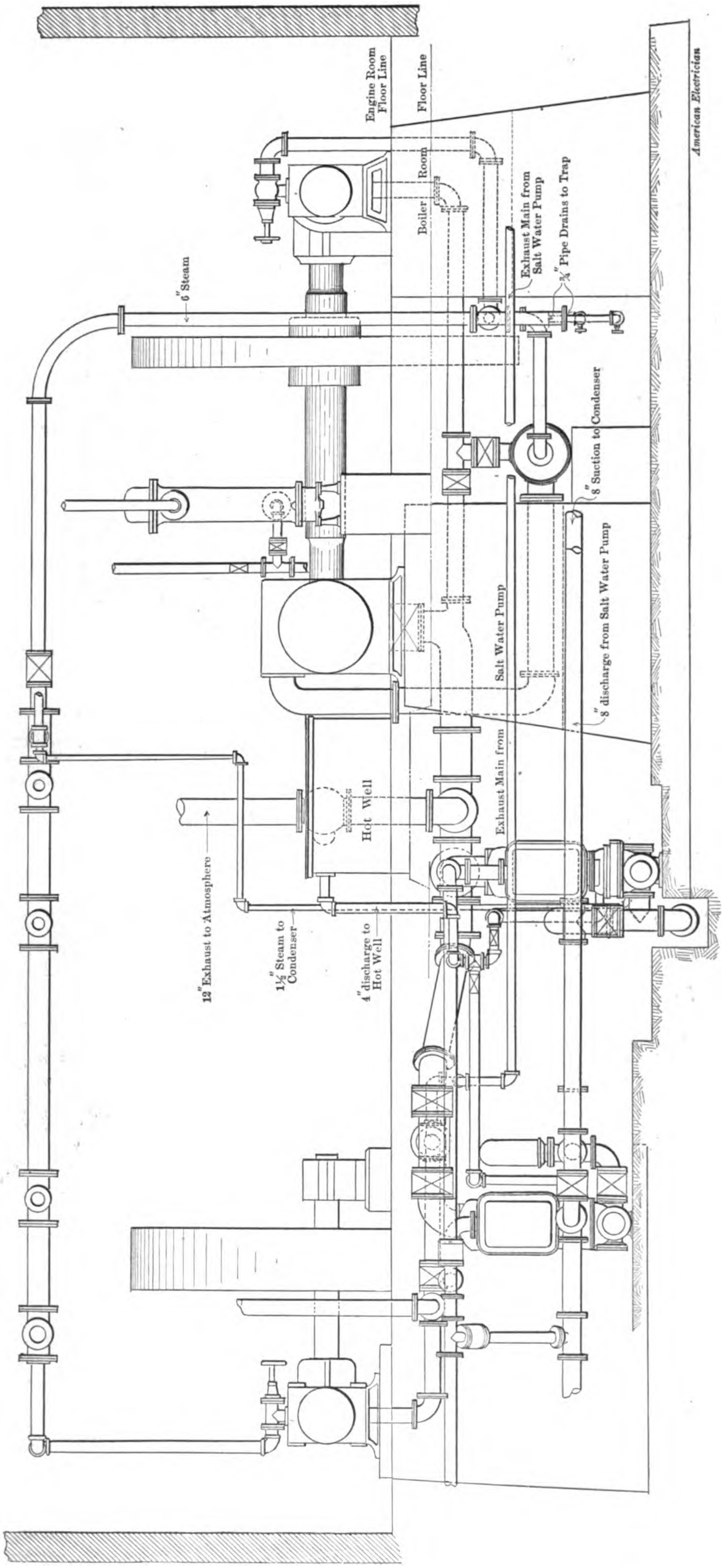


FIG. 6.—ELEVATION OF ENGINES AND CONDENSING APPARATUS.

The large generator panel has a double-throw triple-pole oil-break switch, one main exciter double-pole switch, a field rheostat for the exciter, a field rheostat for the generator, two ammeters, one voltmeter, and a synchronizing plug. There is one feeder panel for the high-tension line, one for a special feeder to the Soldiers' Home and one for the local Santa Monica distribution. Each of the first two has a triple-pole double-throw oil-break switch for throwing the feeder onto either the upper or lower bus; a recording wattmeter, three ammeters and a voltmeter. The Santa Monica feeder panel has three single-phase circuits going out from it and is equipped like any single-phase feeder panel. The three single-phase feeders are provided at the switchboard with General Electric "C. R." type compensating regulators which will raise or lower the voltage 10 per cent. The arc lighting of Santa Monica is done by means of G. E. alternating-current series arcs supplied from two 25-light "tubs" or constant-current transformers.

From the high-tension feeder panel on the main board three 100-kw. G. E. oil-cooled high-tension transformers take current and "step up" the e.m.f. to 22,000 volts. The outgoing high-tension board is equipped like the high-tension boards in the sub-stations, described below.

The sub-stations are of brick and concrete, with an office in one end and the transformer room in the other. All of the sub-stations have the same apparatus, so there is uniformity throughout. Each sub-station has three 50-kw. oil-cooled and insulated General Electric transformers stepping down from 22,000 to 2200 volts. The three incoming leads are provided with G. E. fuses, each consisting of a flat aluminum strip eight inches long held between spring tension terminals and clamped between two lignum-vitae blocks with an opening in the block opposite the center of the fuse. There are also knife switches in the incoming 22,000-volt leads. The switches have no handles, but are operated by a long wooden pole with a hook on the end. These knife switches are shown in the upper right-hand corner of the board at the Long Beach sub-station. The fuses are behind the board. On each of the 2200-volt secondary leads there is a quick-break triple-pole oil switch located just below the high-tension switches.

There are three single-phase lines taken out of each sub-station. Each is fused with a G. E. enclosed fuse, as seen at the top of the left-hand panel in Fig. 1, and each phase has an ammeter, a two-pole knife switch and a G. E. potential regulator. At the left is a voltmeter which can be used on any of the three circuits by plugging in. The fuses and high-tension switches are well provided with arc guards, as can be seen from Fig. 2. During the early part of the evening a man stays at each sub-station to watch the voltage; the rest of the time the sub-station is unattended. Although no power work has been taken on as yet there are irrigation pumps aggregating 800 horse-power scattered along the line that are now operated by gasoline and steam engines and these will probably be secured as customers.

There are 40 miles of high-tension line;

but the longest distance over which current is transmitted is 35 miles. The transmission line consists of three No. 6 medium hard drawn copper wires on "Provo No. 1" glass insulators furnished by the Hemingway Glass Company, of Covington, Ky. These insulators get their name from the 40,000-volt transmission plant at Provo, Utah, where they were first employed; they are 7½ ins. in diameter.

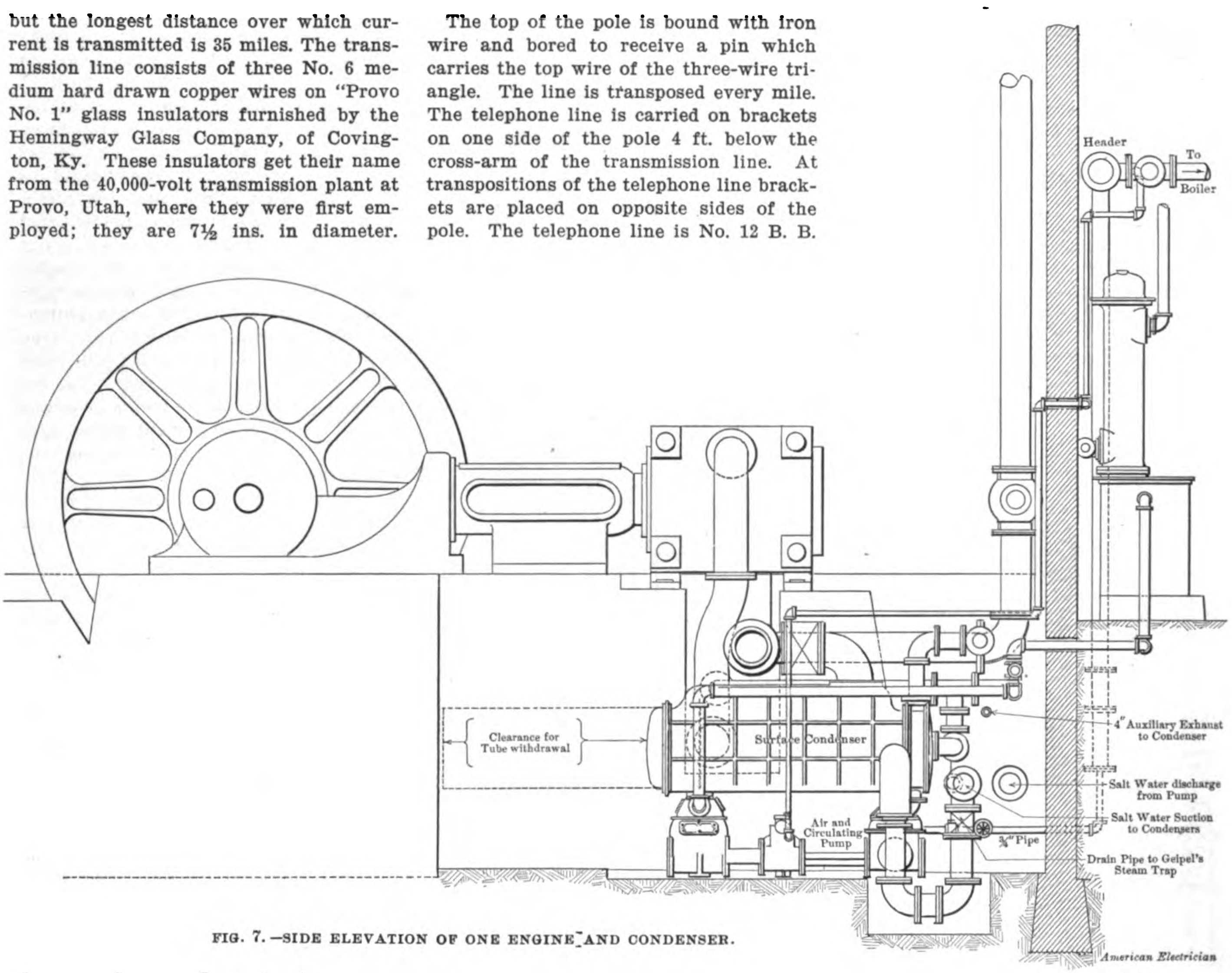


FIG. 7.—SIDE ELEVATION OF ONE ENGINE AND CONDENSER.

There are also some Locke insulators. The insulator pins are 12½ ins. long over all, 8½ ins. from the top to the shoulder, and raise the insulator 4 ins. from the cross arm. They are made high to prevent leakage from the edge of the insulator to the cross-arm. The cross-arms and pins are boiled in linseed oil. The cross arms are 44 ins. long and carry a pin on each end; the distance between wires is 34 ins.

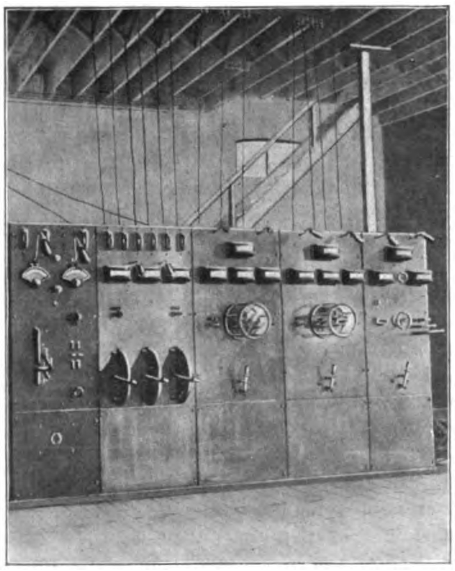


FIG. 8.—SWITCHBOARD.

The top of the pole is bound with iron wire and bored to receive a pin which carries the top wire of the three-wire triangle. The line is transposed every mile. The telephone line is carried on brackets on one side of the pole 4 ft. below the cross-arm of the transmission line. At transpositions of the telephone line brackets are placed on opposite sides of the pole. The telephone line is No. 12 B. B. iron wire, and is carried on pony double-petticoat glass insulators. The poles are spaced 130 ft. apart; they are 35 ft. long in the country and 40 ft. long in the towns. The line is designed to transmit 300 kilowatts and is now carrying 150.

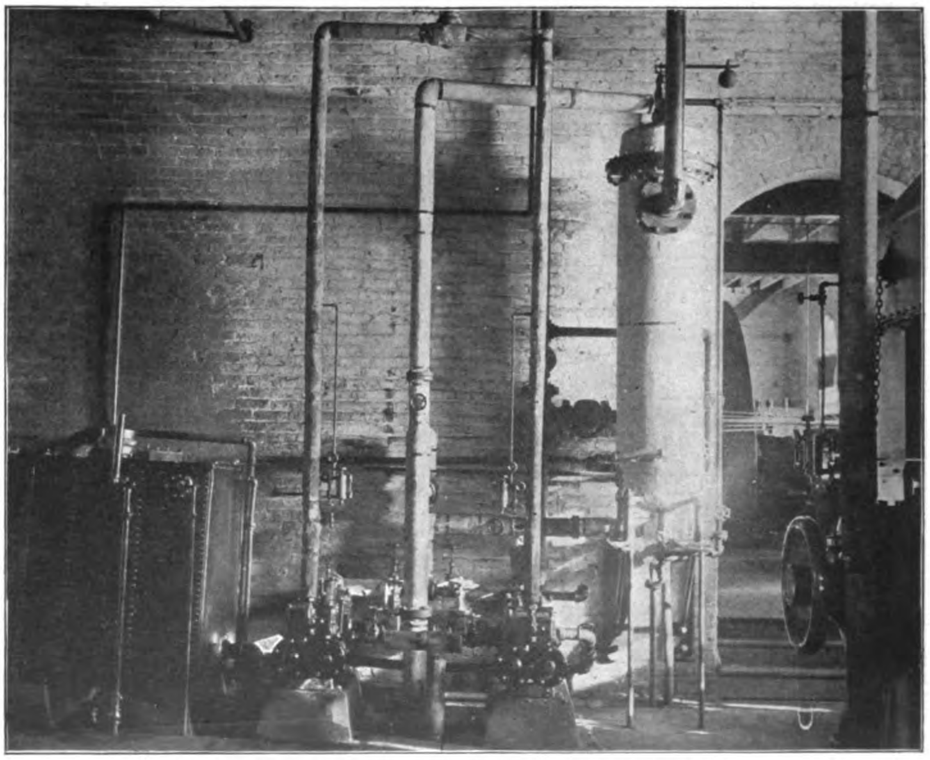


FIG. 9.—HOT WELL, BOILER FEED PUMPS AND HEATER.

The apparent energy required to charge the line is 34 kilowatts. The voltage is 16 per cent higher at the far end than at the Santa Monica power house, due to the capacity of the line.

It should be mentioned here in connection with the change from small power houses to sub-stations in some of the villages that there were some old 125-cycle 1,000-volt plants. The plant just described is 60-cycle. The discrepancy was provided for by connecting the primaries of two 1000-volt transformers in series and their secondaries in parallel, and going ahead with the old transformers at 60 cycles.

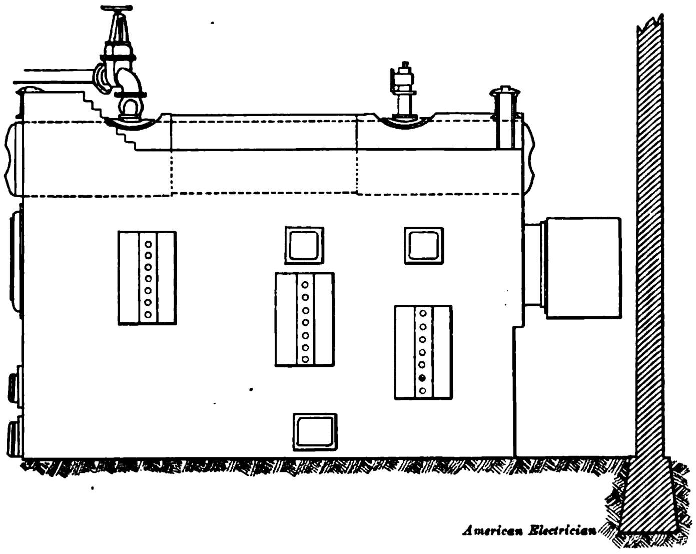

American Electrician

FIG. 10.—BOILER SETTING.

The United Electric, Gas & Power Company has main offices at 254 South Broadway, Los Angeles, Cal. Mr. J. J. Davis is the superintendent, and acknowledgment is due him for many courtesies extended in connection with the preparation of this article.

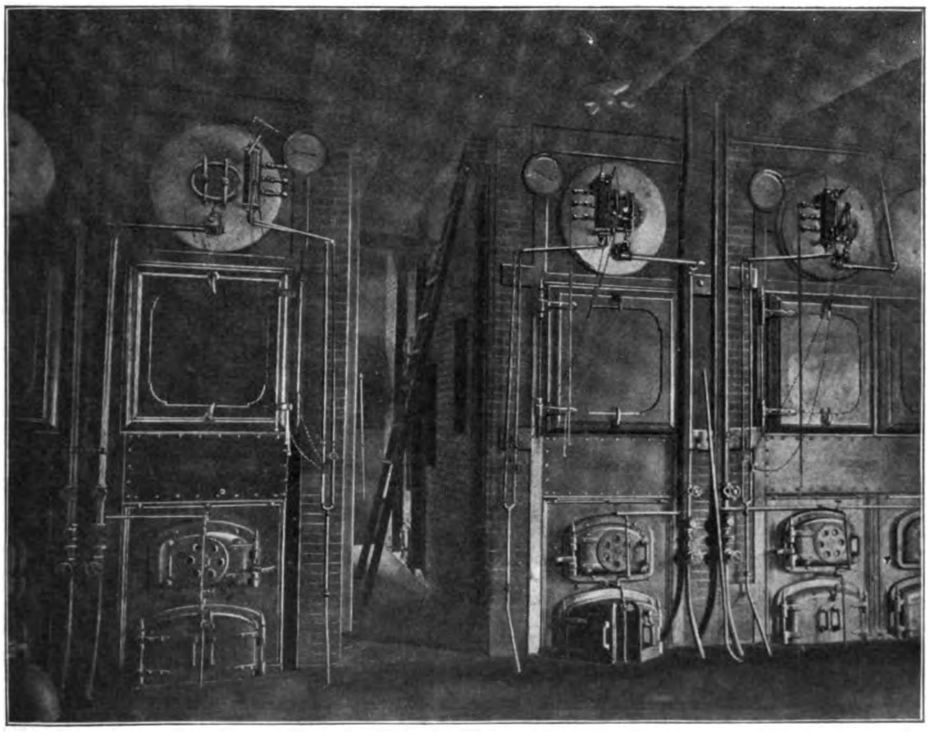


FIG. 11.—PARTIAL VIEW OF BOILERS.

ELECTRICITY IN COAL MINING IN THE PITTSBURG DISTRICT.

BY WM. G. IRWIN.

While the application of electricity to coal mining dates back some years, yet it is within comparatively recent years that the intelligent and economic use of this agent in coal mine operation has received any considerable attention in this district. To-day electric lighting, even to the workings, electric haulage and electrical and compressed air machine mining have in a large degree superseded the older methods and at the same time these modern methods have removed many of the sources of danger in coal mining. Although electric lighting was introduced in the Connellsville coke region more than ten years ago and has in a large degree obviated the necessity of miners' lamps, the more extended use of electricity first came into use in the mines of the Pittsburg gas coal seam, having been here introduced after the success of elecricity had been established through its use in the mines of the anthracite fields.

About eight years ago the W. L. Scott Coal Company installed a complete electrical power plant at Scott Haven, on the Youghiogheny, for the purpose of furnishing electric lighting for its mines as well as for furnishing haulage power and electrical power for operating mining machinery. Ever since that time electricity has been in successful use at these mines (which are to-day the property of the Pittsburg Coal Company). Save for the purpose of gathering the cars in the headings the pit mule is now entirely supplanted by electricity in these mines. At first some little trouble was experienced with the trolley wires, but experience has eliminated these troubles.

Since that time there have been numerous installations of electric power plants at the mines in the same district, and while there are no available statistics as to the proportion of electrically equipped plants and the annual output of such mines, it is known that they form an important figure in coal mine operation hereabouts. All the new mines being opened up are being equipped with electrical apparatus, and many of the older mines are now changing to the system. Probably one of the most modern mines in Western Pennsylvania is that of the Berwind-White Coal Mining Company at Windber, a description of whose equipment was published in this paper last July. In the coke regions electricity has displaced the old larry system for charging the ovens, and experiments are being made with it in the operation of automatic coke drawing and loading machines.

The economy resulting from the use of these modern methods in coal mining is enormous. Formerly eight mules and as many drivers were required to haul out 200 tons per day, and the cost under the old system was nearly 10 cents per ton. An electric locomotive like those in use at Windber will haul 1000 tons daily at a cost of less than one cent per ton.

Electrical machine coal mining is also in quite general use in the Pittsburg district. These machines are easily manipulated, and in construction they are extremely simple. Of the several electrical mining machines the chain cutting machine is most widely used in this district. This machine can be used in different veins for coal, for it has a height of less than 20 ins., is less than 4 ft. wide and about 8 ft. long. It is equipped with an iron-clad multipolar motor. The cutter-frame consists of a forged steel rail, a cutter head and two steel guides in which the cutter chain runs. This machine will undercut 5 ft. deep and about 3½ ft. wide. In using these machines the only necessary preparation is stringing the wires and the machine is then mounted on its truck and taken into the room where the mining is to be done. It requires about four minutes to make a cut and one minute to withdraw the machine when the jacks are loosened and the cutter moved up for another cut. When shearing is found necessary a vertical cutting machine is used. With these machines it is possible to cut from 50 to 100 ft. of entry per day of ten hours, according to the character of the coal. For the adjustment of mining scales and computing wages it is estimated that one machine will do the work of twelve men.

MODERN PRACTICE IN STEAM ENGINE CONSTRUCTION.

While an industry is young and its field wide and comparatively unobstructed inventions are likely to be numerous, and changes in methods and design are promptly made if thereby a better adaptation of product to conditions is secured. As the industry grows older conditions become better understood, the product of different shops becomes to a greater or lesser degree specialized, the field becomes limited through increasing competition, profits diminish and an increasing tendency appears to resist changes in methods and design, and to compel the adaptation of conditions to what is termed "standard practice."

So far as this tendency acts as a balance wheel by resisting erratic and ill-considered innovations on the one hand and by demanding the elimination or modification of unreasonable conditions on the other, it is a very valuable conserving force; but when it becomes a dead weight by refusing to recognize the right of conditions to be considered, its influence becomes distinctly reactionary to the direct detriment of the industry itself and to the indirect detriment of related industries.

A candid observer, reviewing the improvements in engine design and construction during the last six or eight years, can hardly fail to come to the conclusion that the engine industry as a whole is verging on the dead weight condition and that substantial progress has been confined to hardly more than a half dozen manufacturers out of the scores of engine builders in this country. This is a regrettable condition, since the reactionary influence of the unprogressive builders is a distinct drag on the efforts of the comparatively few moderately conservative, yet progressive, builders to raise the general standard of engine construction; while indirectly the electrical industry has been unfavorably affected.

It will not be out of place to add that a manufacturer can continue to make only what he can sell, and as the first cost of high grade engines is much greater than the first cost of low grade engines, the success of the builders of high-priced engines is in no small degree due to the encouragement and support received from central station managers, superintendents and engineers who have had the judgment and business acumen to select the best the market afforded, looking to decreased operating and maintenance charges and a larger average output for a return on the increased investment; and it is only through their continued encouragement and support that further improvements can be looked for.

Engines may be divided with respect to speed into three groups: high-speed engines, with speeds from 180 r.p.m. up; moderate-speed engines, with speeds from 100 to 170 r.p.m.; slow-speed engines, with speeds below 100 r.p.m. This method of grouping is not strictly accurate, as the several groups overlap to a certain extent, and what may be a moderate-speed engine in one size or type may be a high-speed in some other size or type; nevertheless it is not likely that any misunderstanding will arise on that account since the division indicated is generally accepted by both builders and users. Furthermore, there are certain differences in design which closely follow the grouping by speeds; for example, the dominating types among so-called high-speed engines have the following characteristics: a stroke not exceeding 24 ins.; self-contained construction; center crank; a single eccentric; a single valve; automatic shaft governors. The dominating types among moderate-speed engines are characterized by strokes from 24 to 48 ins.; side-crank construction, unless the conditions require the side and center crank or the center crank arrangement; single or double eccentrics; four positively driven valves, two for steam admission and two for exhaust; automatic shaft governors. The dominating types among slow-speed engines are characterized by strokes from 42 to 72 inches; side-crank construction, occasionally modified to side and center crank to meet special conditions; single or double eccentrics, releasing valve gear; four valves; fly-ball governors.

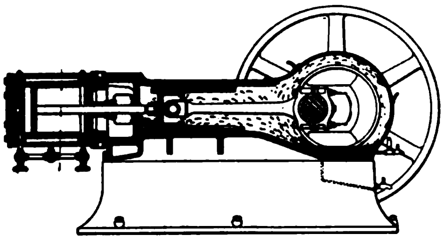


FIG. 1.—SECTION THROUGH SELF-OILING ENGINE.

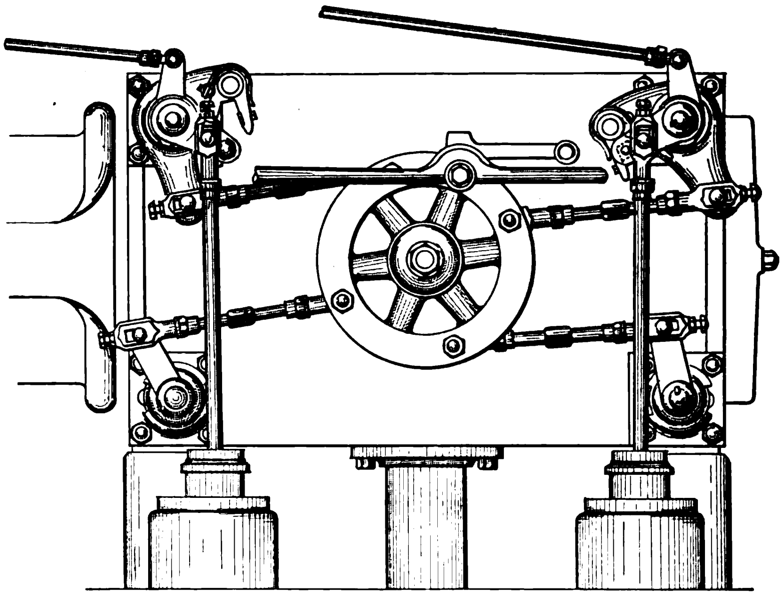

Am. Elec.

FIG. 2—ORDINARY FORM OF CORLISS GEAR.

High-speed engines show few improvements. Shafts and pins have in some instances been increased in size. Two or three builders have designed a very satisfactory form of shell bearing. An example of a bearing with removable shell and adjustable quarter boxes, designed for a large engine, is shown farther over by Fig. 19; the advantages of such a design seem obvious, since it allows the removal of the bottom shell with a minimum amount of dismantling and loss of time; nevertheless, many builders still adhere either to solid bearings or bearings provided with flimsy, unmechanical liners.

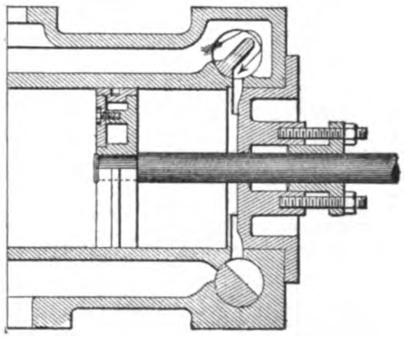


FIG. 3.—ORDINARY FORMS OF CORLISS VALVE.

The most conspicuous change is in the methods adopted to prevent waste and throwing of oil. Something has been gained by the substitution of grease for oil to lubricate the governor mechanism and more or less of the valve gear, but the main reliance has been placed upon the thorough enclosing of all working parts. The desire to promote cleanliness is most commendable and the method adopted has been fairly successful, but unfortunately many builders have enclosed the working parts in such a way as to seriously interfere with their accessibility both for inspection and for repairs. Fig. 1 shows a section through a self-oiling engine in which this system of lubrication has been very thoroughly worked out; the rotation of the crank discs fills the case with a spray of oil which reaches all parts of the guides and the crosshead pin; a portion of the oil is caught in a trough on the inside of the hood in front of the discs and is delivered by pipes in a continuous stream to the main bearings and the crank-pin.

As a class, engines of this group have too high a rotative speed, clearances are abnormally large, methods for following up wear are crude or altogether lacking, details are designed primarily to reduce the first cost and secondarily, or not at all, with a view to reducing the cost of repairs and renewals, and attention is concentrated on such relatively unessential features as the precise method by which lubrication is secured and the ability of the governor to maintain the average speed within abnormally narrow limits—to the partial or complete exclusion of questions relating to cost of operation and maintenance, reliability, and economy.

The most interesting of the three groups is the intermediate group, comprising engines running at speeds within the limits, somewhat arbitrarily imposed, of 100 and 170 r.p.m. The growth and development of this group have been exceedingly rapid during the past five or six years and it is probable that its importance will increase even more rapidly in the future than in the past, and that it will encroach more and more upon the fields now occupied by the high-speed and slow-speed groups, since the growing tendency is to decrease the speed of high-speed engines above about 300 horse-power and to increase the speed of slow-speed engines of all powers.

In the high and slow-speed groups, especially the former, there are comparatively few differences in the general de-

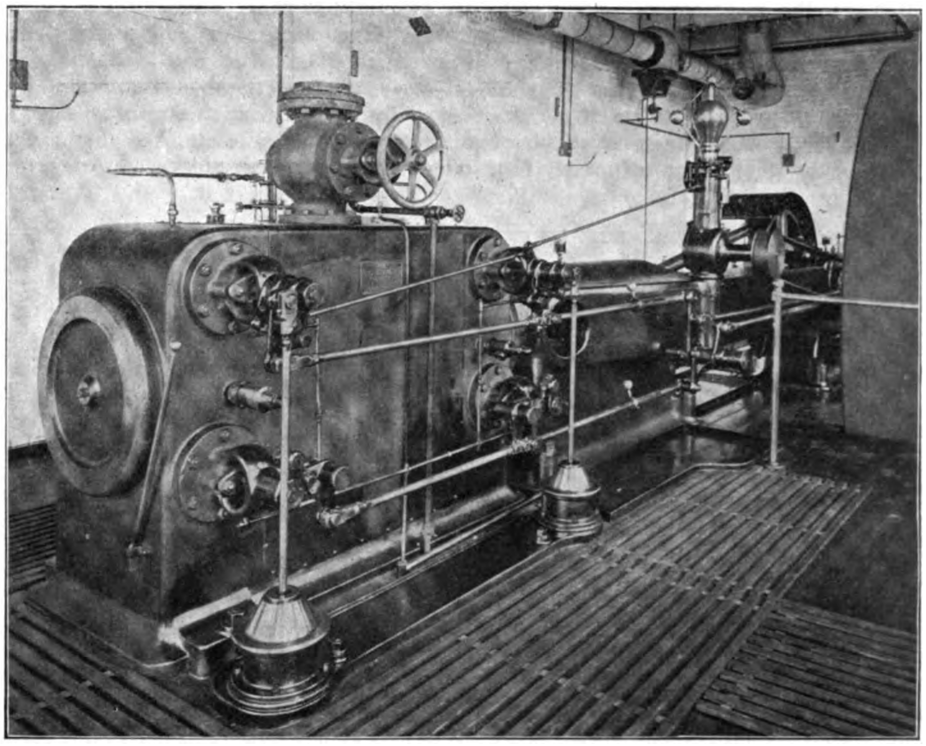


FIG. 4.—DIRECT-ACTING CORLISS VALVE GEAR, OBVIATING WRIST PLATES.

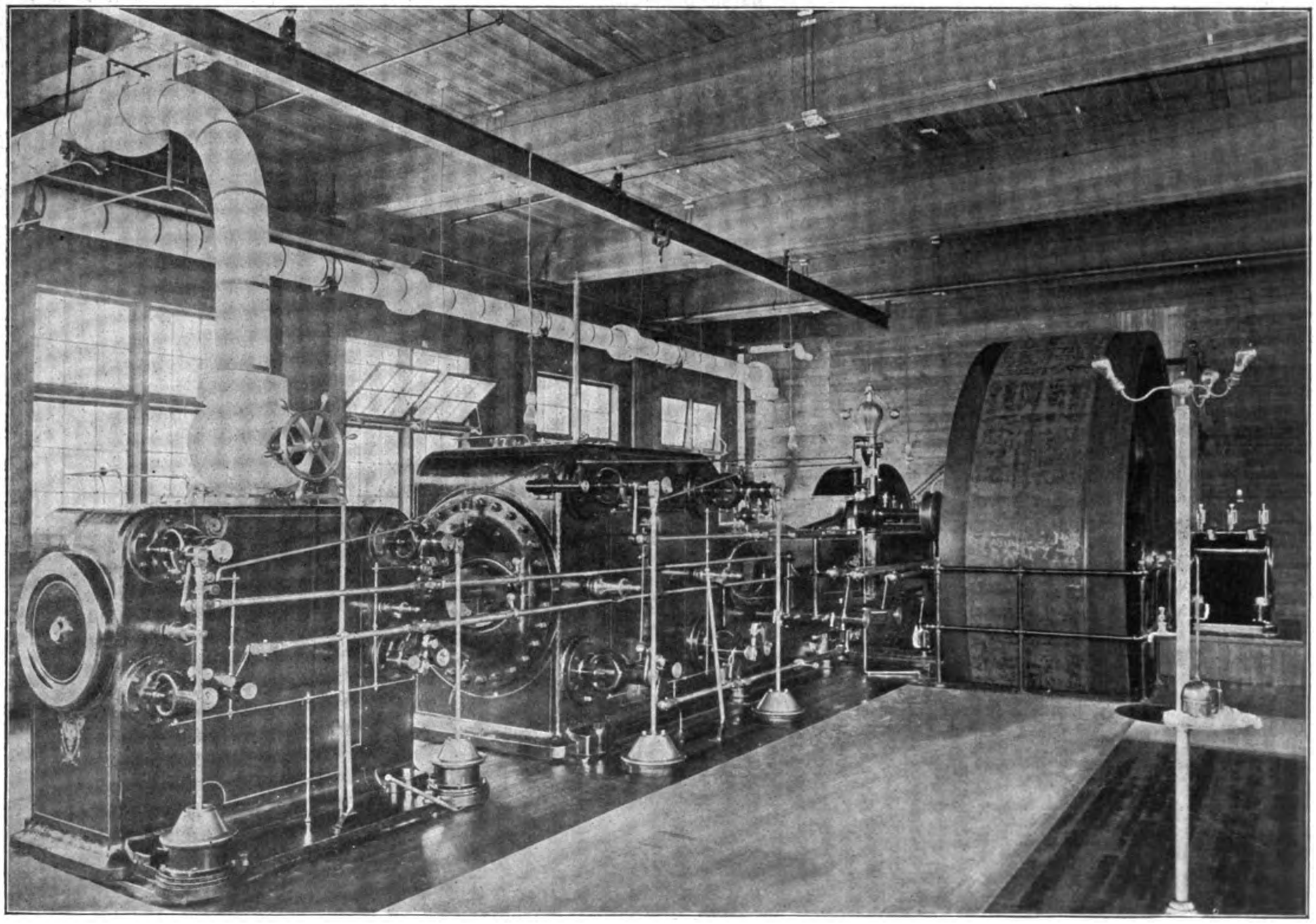


FIG. 5—DIRECT-ACTING CORLISS VALVE GEAR APPLIED TO A TANDEM COMPOUND ENGINE.

sign, but among moderate-speed engines practice is still divergent in several particulars, the most conspicuous of which are the valves, valve gear and governing mechanism. A few builders still persist in attempting to adapt valves and cylinder construction of the distinctively high-speed type to moderate-speed engines, but as these attempts must ultimately fail, it is not necessary to discuss them here; such engines are uneconomical in steam consumption, whereas the foundation of the success of moderate-speed engines is, and must be, a degree of steam economy closely approaching that of slow-speed engines combined with a higher degree of economy of material. The method generally followed has been the adoption of the design of valves and (to a less extent) valve mechanisms of slow-speed engines which have proved their economical qualities, and the modification of these valves and gears to suit higher speeds and the style of governor used.

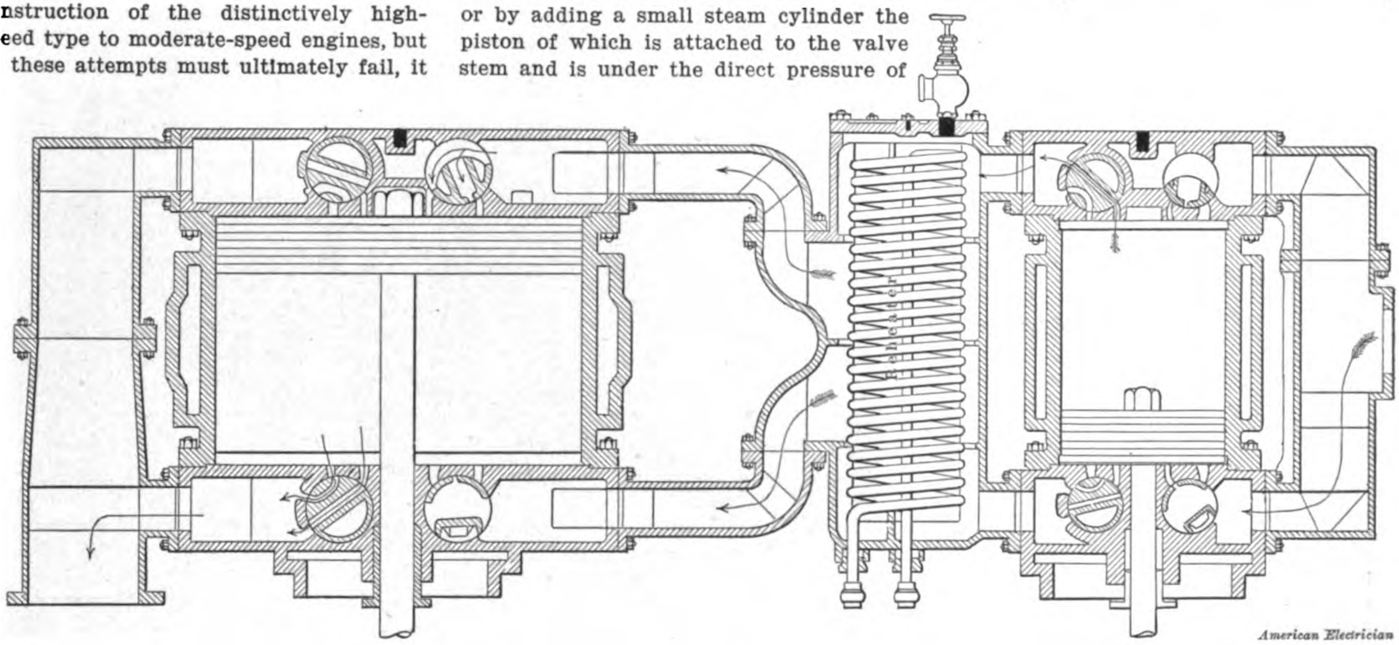


FIG. 8.—A CROSS-SECTION THROUGH THE CYLINDERS OF A VERTICAL COMPOUND CORLISS ENGINE HAVING A POSITIVELY-DRIVEN VALVE GEAR.

With but few exceptions manufacturers of releasing-valve-gear engines have ignored or refused to attack the fundamental limitation to their success in this field —the fact that the speed of such engines is strictly limited by the releasing feature of their valve gear, since only within narrow limits can the speed of valve movement in closing be independent of the engine speed. To meet tne demand for higher speeds the principal builders have lightened their valves and gear; have substituted double for single-ported valves, thus shortening the valve stroke or travel; and have improved the action of the dash-pot. A few builders have gone still further, increasing the rapidity of valve closure by supplementing the action of the dash-pot by means of a spring acting directly on the valve stem or by adding a small steam cylinder the piston of which is attached to the valve stem and is under the direct pressure of live steam. Fig. 2 illustrates the older form of valve gear; Fig. 3 is a section showing single-ported valves. The speed of an engine containing such valves and gear is limited by conservative practice to a maximum of about 85 to 90 r.p.m. for moderate sizes and 75 r.p.m. for large sizes—considerably below the lower limit for moderate-speed engines.

Figs. 4 and 5 illustrate an improved valve-gear of comparatively recent design; the light, neat construction, the absence of wrist-plates, and the easy lines represent a distinct advance over the rather heavy construction and harsher lines usually met with. The method of driving the valves is especially clear in Fig. 4, which shows the cylinder and a portion of the frame of a simple engine. It will also be noted that the cylinder rests on a plate bolted to the foundation, and that the foundation bolt boss has an overhanging lip under which is a projection from the cylinder machined to a close fit; this allows a free movement of the cylinder forward or backward, but prevents any tendency to lift and relieves the structure of the objectionable strains induced by bolting the cylinder itself fast to the foundation. Fig. 5 shows the tandem construction. Double eccentrics are used and the governor controls simultaneously the cut-off on both cylinders.

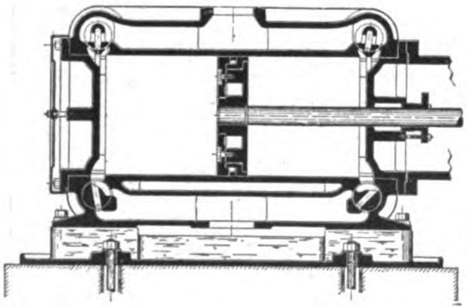


FIG. 6.—IMPROVED FORMS OF CORLISS VALVE.

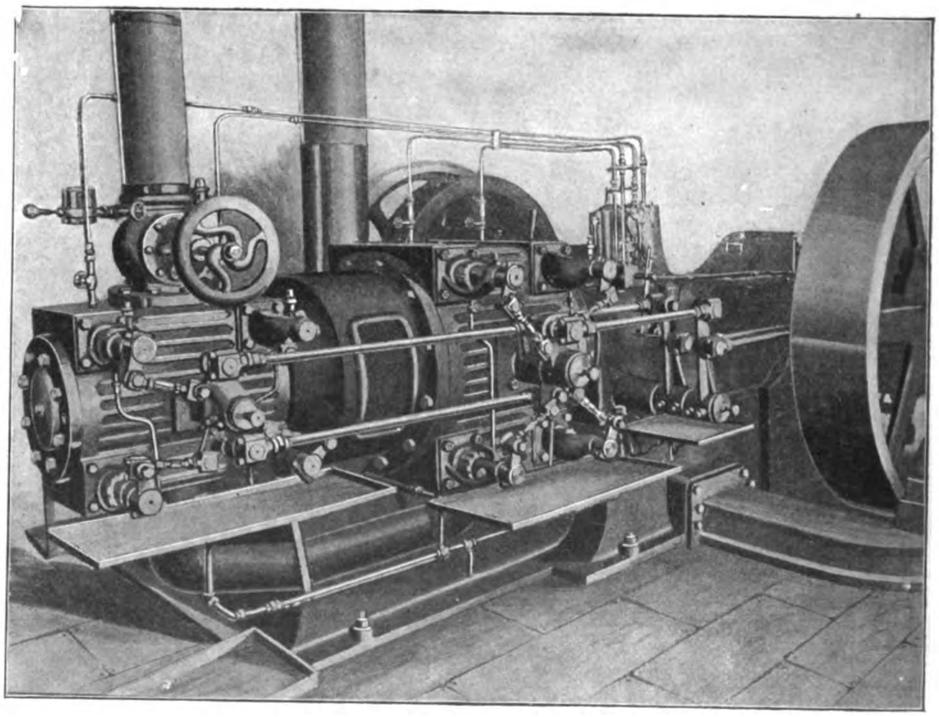
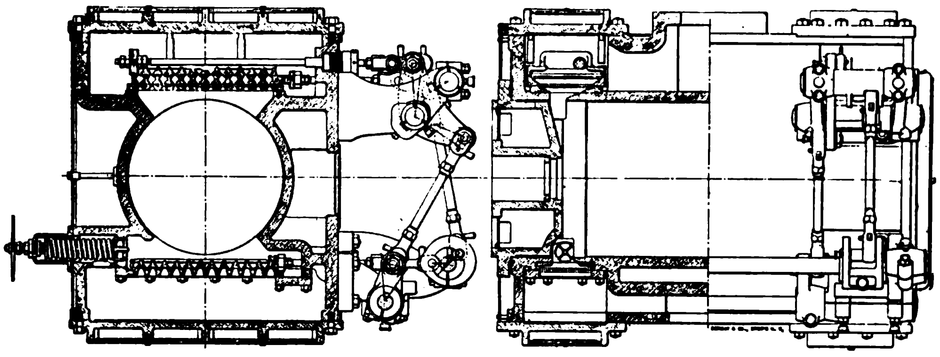


FIG. 7.—A POSITIVELY-DRIVEN VALVE GEAR HAVING NO RELEASE.

Fig. 6 shows in section a comparatively light, short stroke, double-ported valve which is used in another Corliss-type engine.

The superiority of these later constructions is clearly apparent merely from a mechanical standpoint, but their chief advantage lies in their permitting an increase in the speed of small engines to 110 and of moderate sized engines to 100 r.p.m., bringing them within the moderate-speed group. One or two manufacturers are building engines with speeds up to 120 r.p.m. without and 150 r.p.m. with steam or spring-accelerated valves; but such engines have hardly been tried long enough to demonstrate whether or not these speeds are commercially desirable; in any event the logical solution is the elimination of the question by abandoning entirely the releasing feature and substituting positively-driven, non-releasing forms of valve-gear, as has already been done by several manufacturers, most of whom previously built high-speed engines exclusively. Some of these manufacturers have adopted the Corliss valve, the exhaust valves being driven from a fixed eccentric and the admission valves from a movable eccentric controlled by a shaft governor, the cut-off being determined by the position of the eccentric, and the speed of opening and closing varying directly with the speed of the engine. Fig. 7 shows a tandem-compound engine equipped with this type of valve-gear operating Corliss valves. Fig. 8 shows in section the Corliss valves and cylinders of a vertical cross-compound engine of a different make, in which the same class of positive valve-gear is used.



FIGS. 10 AND 11.—SECTIONS OF THE ENGINE IN FIG. 9, SHOWING ALSO GRIDIRON VALVES.

Other builders have adopted modified forms of slide valves or gridiron valves. A form of the latter is illustrated in Figs 9 to 11, one showing the external appearance of tandem cylinders, the others showing sections through valves and cylinder. As with the Corliss valve arrangement cited above, the exhaust valves are driven from a fixed eccentric, but there is a radical difference in the steam valves, which are double, comprising a main valve driven from the same eccentric that operates the exhaust valves, and a riding cut-off valve driven from a movable eccentric controlled by a shaft governor; as these valves move in opposite directions while opening and closing, the valve travel is short and admission and cut-off are very rapid, the rapidity of these operations varying directly with the speed of the engine.

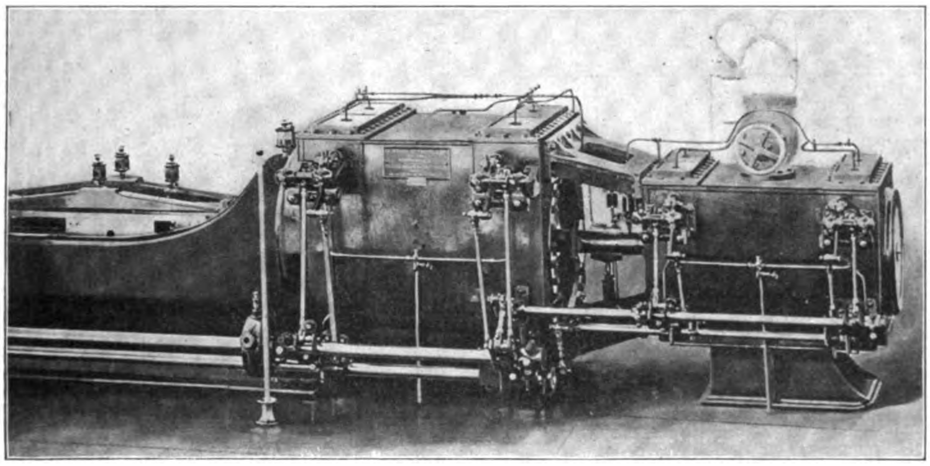


FIG. 9.—CORLISS VALVE GEAR DRIVEN FROM SECONDARY SHAFTS INSTEAD OF WRIST PLATES.

The adoption of the four-valve construction, with the consequent reduction of clearances, has doubtless been a considerable factor in the higher economy of such engines as compared with high-speed engines; but the principal factor has been the increase in the length of stroke and the piston speed, the further decrease in clearances which this permits, and a greatly improved valve design, so that to-day the best moderate speed engines rank with the best slow-speed engines in the matter of steam consumption. For example, a 48-in. stroke engine at 75 r.p.m. shows a certain steam consumption; other things being equal, it will show practically the same steam consumption at 100, 110 or 120 revolutions, while there is a very marked difference in the economy of material, since every increase in speed reduces the weight per unit of capacity.

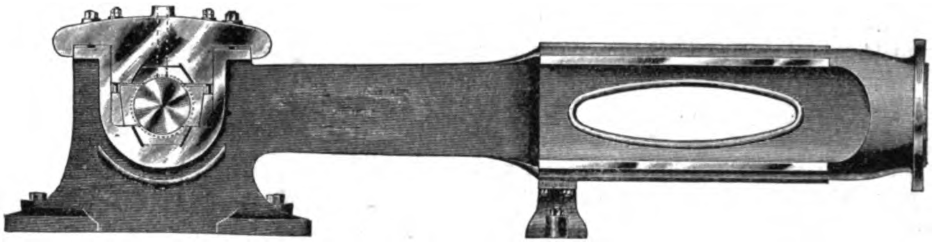


FIG. 12.—OLD-STYLE GIRDER TYPE OF ENGINE FRAME.

Nearly every manufacturer has adhered to the type of governor he originally used; consequently we find in the moderate-speed group all the governors of the high-speed and slow-speed groups—shaft governors on engines designed by high-speed engine builders and fly-ball governors on engines designed by slow-speed engine builders. Both types give very satisfactory results, but the so-called shaft or automatic governor doubtless governs more closely than the fly-ball type, especially under rapidly and widely varying loads, and several manufacturers of releasing-valve-gear engines have experimented with a view to substituting such a governor for the usual fly-ball type.

It is broadly claimed that moderate-speed engines are much more economical than high-speed engines under all conditions, are as economical as slow-speed engines under similar conditions, are adapted to a much wider range of conditions than either high or slow-speed engines, and, all things considered, give the highest return on the investment. The results obtained during the past five or six years seem to justify these claims and the increasing attention shown by high-speed and slow-speed engine manufacturers to this field is a tacit recognition of its importance.

There is little to be said which applies distinctively to slow-speed engines; nearly every improvement has been made under the pressure of competition from the moderate-speed group and in the attempt to lessen the severity of that competition by increasing rotative speeds; all of these improvements appear in engines which are included in the moderate-speed group. Some have been mentioned above and others will be cited in the following paragraphs but without referring them to either the slow or moderate-speed groups as they are common to both.

There still exists the widest diversity in practice with respect to horizontal engine frames. Some builders adhere to the girder type which met reasonably well the light mill duty of 20 years ago, but which is wholly inadequate to meet the exacting requirements of modern electrical work; and in the better class of mill work there is a growing demand for something better. Fig. 12 illustrates the girder type of frame; it is weak in every direction, has insufficient bearing surface on the foundation, and continues to exist only because it is cheap.

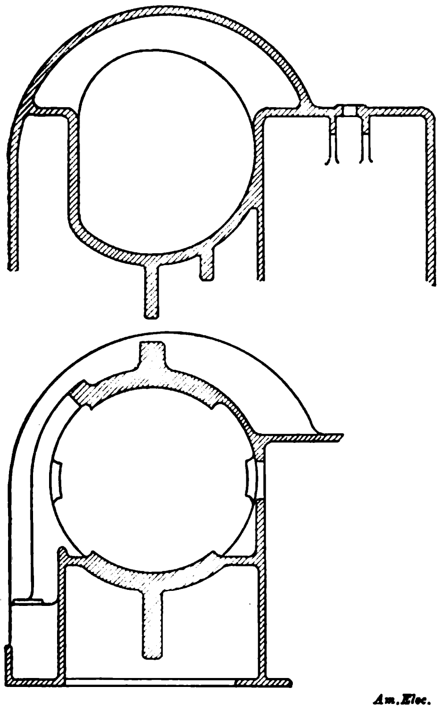


FIG. 14.—SECTIONS OF FRAME SHOWN IN FIG. 13.

The opposite practice is represented by the few builders who have had the courage and good judgment to go to the root of the trouble by discarding old drawings, patterns and methods, and adopting a design of maximum rigidity, strength, bearing surface and grip on the foundation. A good example of such a frame is shown in Fig. 13, sections of which are shown in Fig. 14; it is in one piece, caps the foundation over its entire length and breadth, and relieves the cylinder of certain objectionable strains inseparable from the girder construction. A frame on similar lines, but for another type of engine, is illustrated by Fig. 15, and sections of it are shown in Fig. 16.

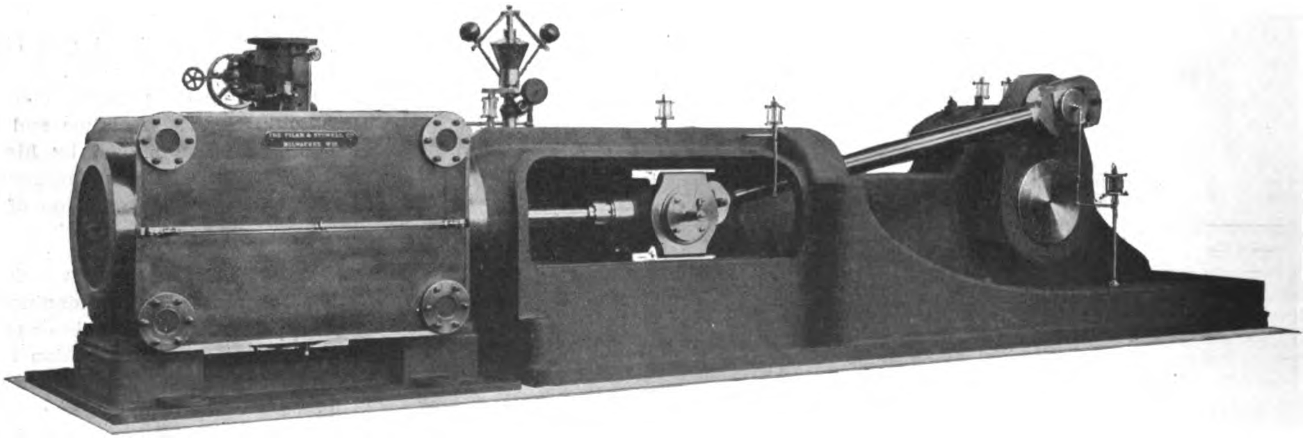


FIG. 13.—MODERN FORM OF CORLISS ENGINE FRAME SUPPORTED THROUGHOUT ITS LENGTH.

There is quite a number of builders who have compromised by putting a substantial frame under the main bearing but retaining the girder construction for the guides and casting the frame in two pieces. An example of this construction is given in Fig. 17; it is a decided improvement over the earlier design, but inferior to the admirable designs illustrated in Figs. 13 and 15. Other modifications consist in casting heavy ribs under the guides, or putting a support under them resting on the foundation and thus transmitting direct to the foundation strains which would otherwise reach it through the cylinder.

It is, perhaps, but natural that one should find in bearings the same diversity that has been noted in frames; still there is less excuse for antiquated and inconvenient construction, since a good bearing is not difficult to design, involves comparatively slight changes in patterns, and the additional cost is inconsiderable. Occasionally one finds solid bearings, that is, bearings with the babbitt cast directly in the frame or outboard pedestal; such bearings can be properly scraped or rebabbitted only by lifting the shaft entirely out, and it is surprising that they are tolerated. The more usual construction consists of a flat-bottomed shell with quarter boxes. Fig. 18 shows a bearing of this type; here the adjustment for wear is made entirely from one side and by means of set screws, both of which features are objectionable. The frame in Fig. 12 also shows a bearing of this type, but both quarter boxes are adjustable and are followed up by solid wedges extending their entire length.

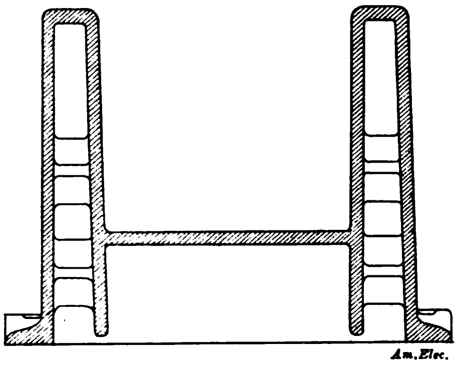


FIG. 16.—SECTION OF FRAME SHOWN IN FIG. 15.

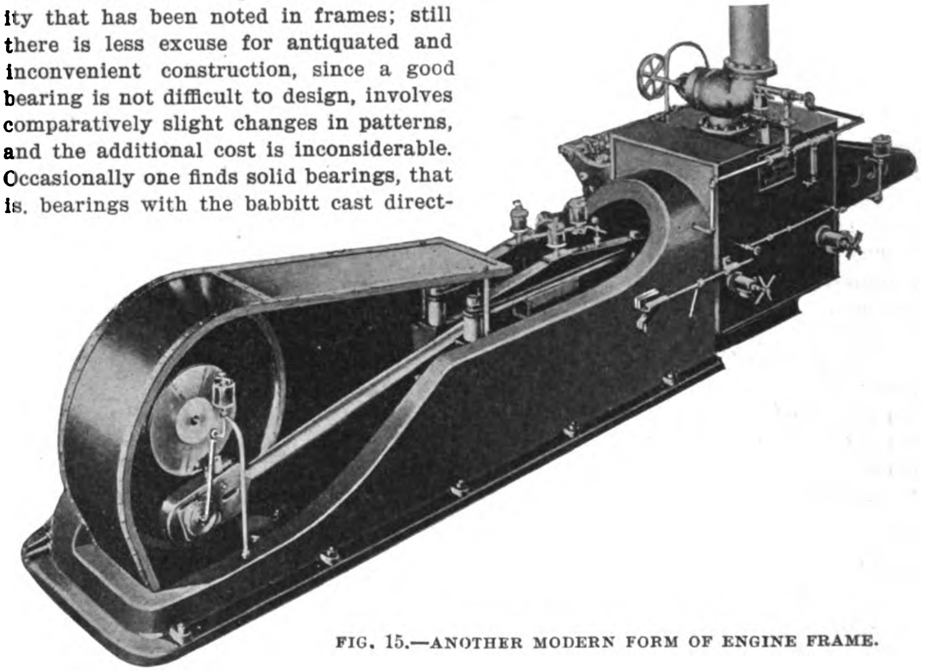


FIG. 15.—ANOTHER MODERN FORM OF ENGINE FRAME.

Flat-bottomed shells for bearings are objectionable for two reasons: they are not self-aligning and usually can be removed only by jacking up the shaft several inches; in the case of direct-connected units, lifting the upper field of the dynamo and jacking up the shaft, wheel and armature 5 to 10 ins. is a slow, hazardous and often expensive operation, the greater part of which may be avoided by making the lower shell cylindrical so that it can be revolved around the shaft by simply jacking up the shaft sufficiently to relieve the bearing of weight, and this can be done without dismantling either engine or dynamo. This construction is shown in Fig. 19, the lower shell being also water jacketed, an excellent feature, but found in few engines.

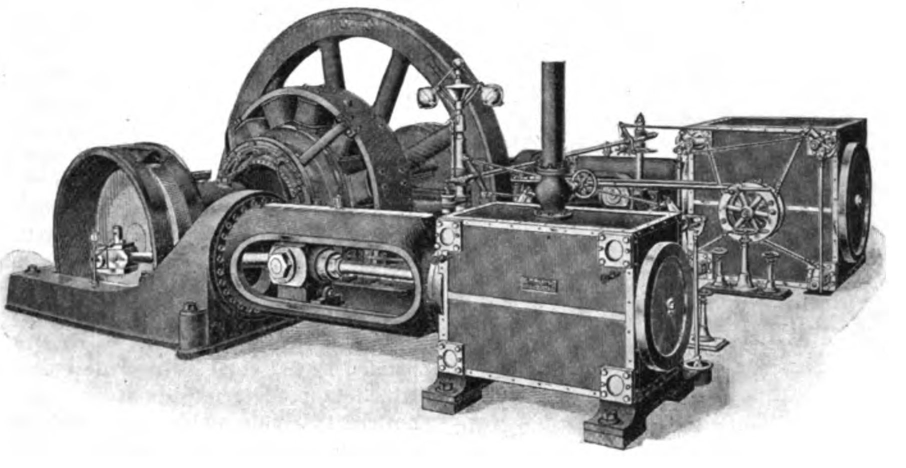


FIG. 17.—AN INTERMEDIATE TYPE OF ENGINE FRAME.

There is a widespread prejudice against tail-rods for horizontal engines; this prejudice is really unwarranted and has cost thousands upon thousands of dollars in reboring, bushing and renewing cylinders, in new pistons, and in the delays incident to making those changes. Do not misunderstand the use of the term "unwarranted." It will be granted that with few exceptions tail-rod constructions have been mechanical monstrosities and that of the two evils the bull-ring piston is the lesser; but purchasers are not obliged to accept such constructions, since there are proper constructions which can be had by requiring them, and therefore a prejudice based on the deliberate selection of an inferior design may fairly be stigmatized as unwarranted.

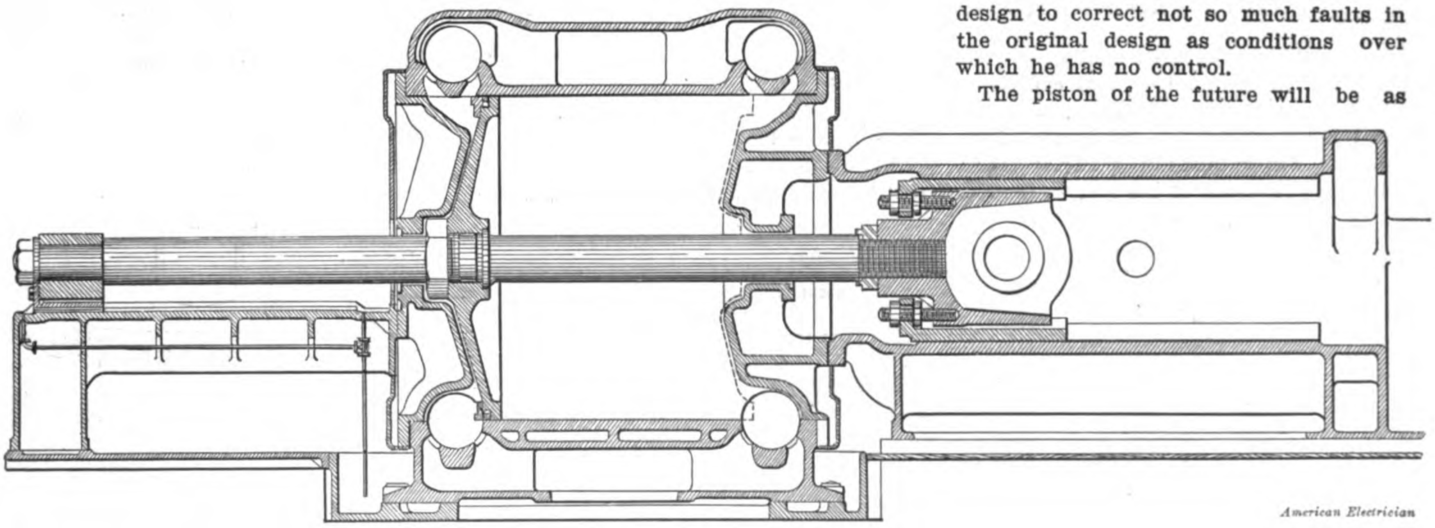


FIG. 20.—SECTION THROUGH CYLINDERS AND GUIDES OF A MODERN CORLISS ENGINE, ALSO SHOWING THE MOUNTING OF THE TAIL-ROD.

A substantial construction is shown in Fig. 20; the cylinder is 76 ins. in diameter and has 60 ins. stroke; the back end of the rod is carried by a cross-head so that the piston is supported between two fixed points; the piston is light and may be partially supported and steadied by the cylinder wall with but a slight increase in the rate of cylinder wear.

Fig. 21 shows an overhung tail-rod support on a 36-in. stroke cylinder; this construction dispenses with foundation work under the support and is suitable for all but very long stroke engines when a foot is placed under the free end. As in the former case, the back end of the rod is carried by a cross-head. This manufacturer also turns the piston rod under a transverse strain equivalent to its own weight and that of the piston, so that the rod is straight when the parts are assembled and supported between the two cross-heads; this method is far superior to bending or cambering the rod, or to stiffening it by using a hollow rod of large diameter.

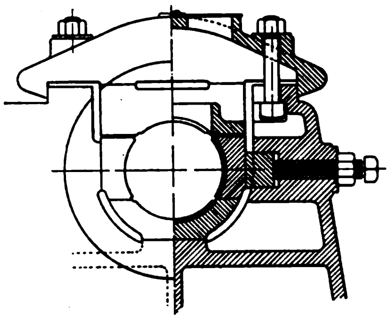


FIG. 18.—MAIN BEARING.

There is probably no single detail in the construction of an engine which has been the subject of as much complaint from purchasers or of as much thought on the part of designers as the piston and rings. A list of all the complaints and a description of all the pistons and rings which have been tried would fill a volume of considerable size, and therefore cannot be attempted here; there are manufacturers who have designed and tried ten or more distinct constructions, yet it is improbable that to-day there is a single design against which complaints have not been lodged. Many, perhaps most, of the complaints have been unwarranted, the trouble being caused by unfavorable conditions rather than by the construction of the piston or rings; but as the conditions generally disappear with the stopping of the engine, while the results, piston and rings are clearly in evidence, the deduction is immediately drawn that the piston and rings constitute the sole condition that causes the results. This form of reasoning and the exposure of its fallacy are certainly as old as recorded history and probably much older; but it is still resorted to, and if the designer cannot definitely point out fundamental causes apart from the piston and rings, his failure is accepted as an admission of the correctness of the deduction, and he is urged to make a new design to correct not so much faults in the original design as conditions over which he has no control.

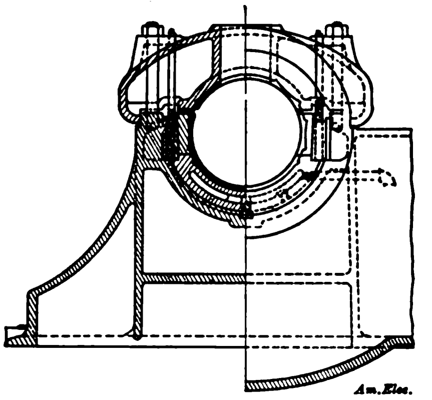


FIG. 19.—MAIN BEARING.

The piston of the future will be as strong as steel and as light as aluminum; will automatically adjust itself so that it will not strike the heads, irrespective of adjustments in bearings; will automatically and instantaneously enlarge the clearance spaces to accommodate doses of water, irrespective of quantity or frequency; will always keep central in the cylinder; will not spring under pressures 50 per cent higher than it was designed for; and will not slam sideways even after the cylinder has been bored out so that there is a ¼-in. clearance all the way around.

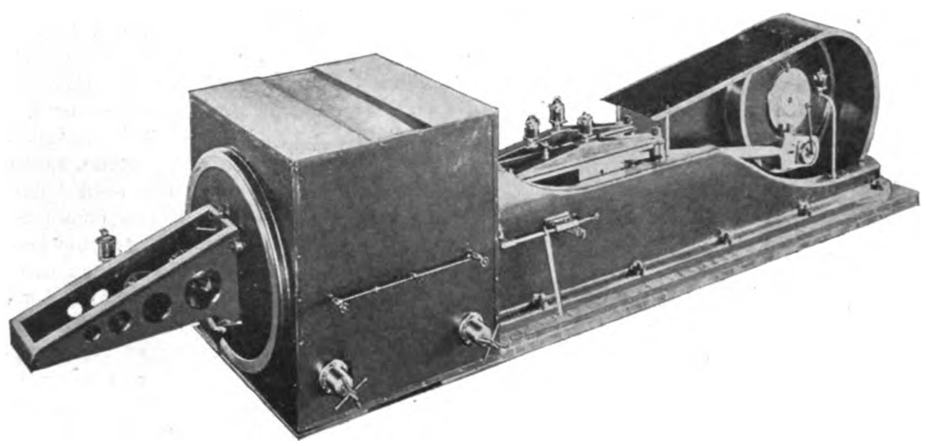


FIG. 21.—ENGINE HAVING A SELF-CONTAINED GUIDE FOR THE TAIL-ROD.

Piston rings of the future will take all of the wear but will last indefinitely; will be steam tight without appreciable pressure against the cylinder walls; will fit perfectly either round or oval cylinders; will work without lubrication; will not lose their tension under any degree of superheat; will automatically adjust themselves to the width of the slot so that no steam can get behind them; will clean the cylinder walls of grit and push it out through the exhaust ports, even in vertical engines, without allowing a single particle to get between the rings and the wall; and will notify the engineer, without the necessity of an inspection, a sufficient length of time before they require renewing, so that he may order new rings and have them on hand against the hour when they ask to be placed on the retired list, which will be at a time when the engine is shut down for rest and recuperation and the engineer is wondering what he can do to kill time.

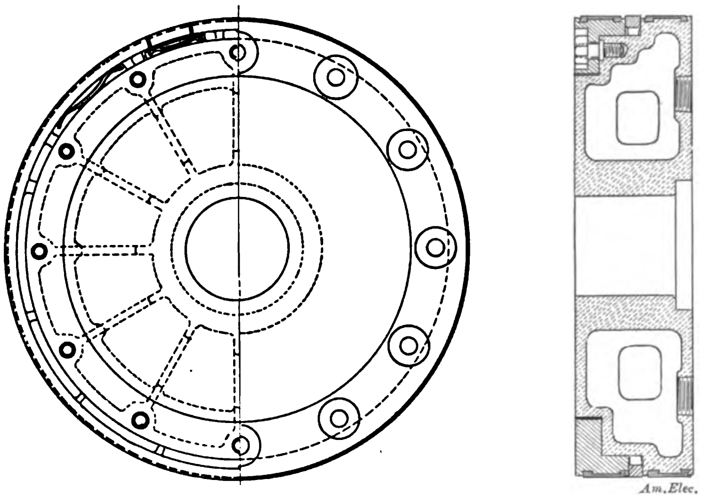


FIG. 22.—A BABBITTED BULL RING PISTON.

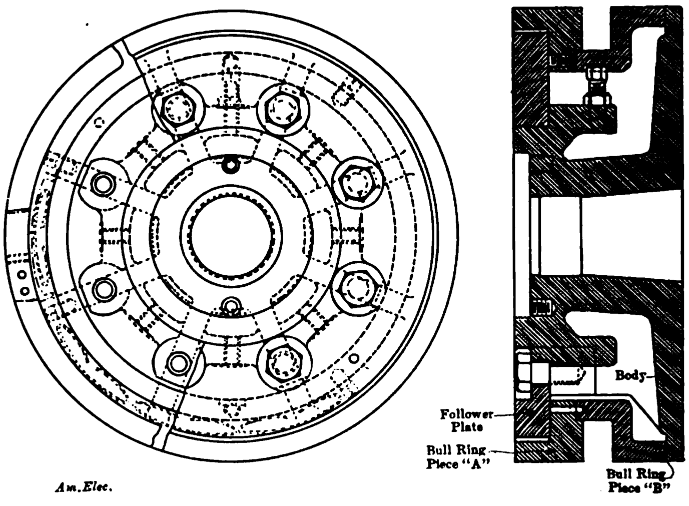


FIG. 23.—AN UNBABBITTED BULL RING PISTON.

In short, the piston and rings will be endowed with qualities of mind and matter which will place them in an order of sentient beings considerably above the average human being.

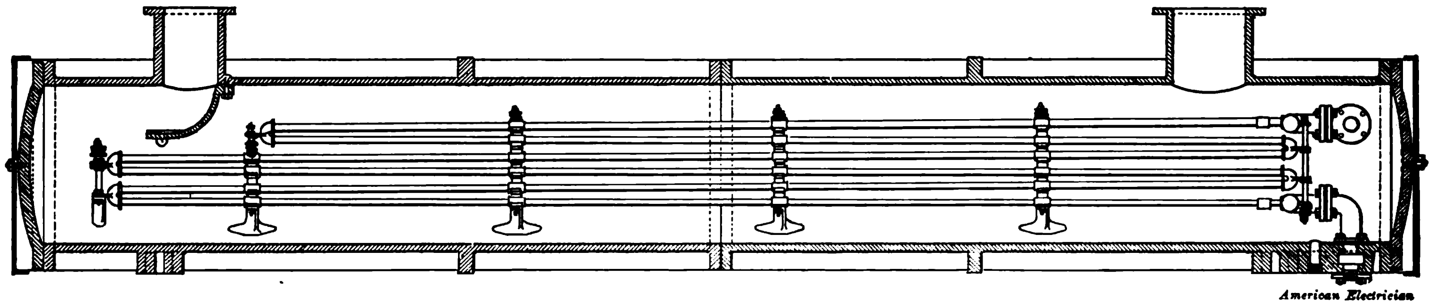


FIG. 24.—LONGITUDINAL SECTION OF A MODERN REHEATING RECEIVER.

Having described the construction that will be wrought out in the future, if the world lasts long enough, we will return to present-day practice. Figs. 22 and 23 show two constructions which, while yet inanimate and inorganic, and therefore extremely low in the scale of possible evolution, nevertheless have met with a favorable reception and seem to meet the requirements fairly well when controlled by external intelligence. The piston in Fig. 22 is well adapted for moderate pressures and saturated steam; the babbitt facing gives a smooth rubbing surface that does not abrade and takes nearly all the wear. In the presence of grit the value of the lining is doubtful; some claim that it is an advantage, as the grit beds itself in the babbitt, thus reducing the tendency to cut, while others claim that the grit, after bedding itself in the babbitt, will continue to cut until the lining is replaced, whereas with an all-iron face the grit will be gradually worked out of the cylinder into the exhaust. But, of course, it is not to be expected that ordinarily grit will be found in a cylinder. The ring is expanded by flat steel springs the tension of which is predetermined; it will also be noticed that side plates cover the opening between the ends of the ring to prevent steam from blowing through or working under the ring and forcing it out against the cylinder walls with an abnormal pressure—a frequent cause of excessive wear and cylinder cutting. The construction is not suitable for very high pressures or highly superheated steam, as the babbitt will not stand the temperature and the unequal expansion between the iron and the babbitt tends to loosen the lining, which when once loose rapidly goes to pieces.

Fig. 23 shows the construction of a bull-ring piston adapted for high as well as low pressures and for any degree of superheat short of a temperature which will destroy the tension of the steel expanding springs. The design embodies several unusual features and has been found to meet satisfactorily a very wide range of conditions; studs are inserted in the bottom of the slot and adjusted so that they almost touch the inner circumference of the ring when in position in the cylinder; this prevents the ring from collapsing on the springs while under steam pressure when over-running the counterbore, keeps the piston central, and prevents it from being blown to one side by the inrush of steam at the beginning of the stroke. Two grooves turned in the outer circumference of the ring assist the lubrication and serve an important purpose in facilitating the escape of any steam that may work under the ring, the steam escaping from the interior into these grooves through small holes drilled at intervals through the ring, and then working out between the face of the ring and the cylinder wall; the same ring is also used with other piston constructions. The bore for the piston rod is tapered, as this ensures a better fit and a firmer grip on the rod than can be secured with a straight bore and shoulder.

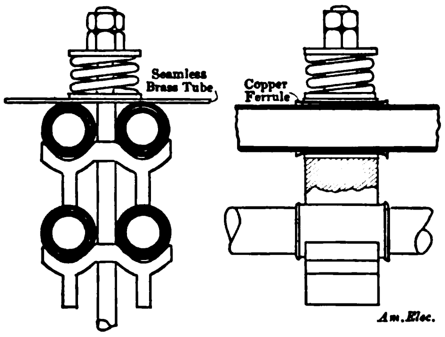


FIG. 25.—DETAILS OF REHEATER TUBE FASTENINGS.

The value of cylinder jackets and reheating coils between high-pressure and low-pressure cylinders has been much debated, but until recent years there has not been a sufficient body of reliable evidence on which to base positive conviction. The judgment of those manufacturers who have given the subject most attention may be briefly summarized as follows: High-pressure cylinder jackets have a small value, and aside from their steam economy are useful for warming up the cylinder before starting; intermediate reheaters have a decided value if properly proportioned and used; low-pressure cylinder jackets are likely to be wasteful, or at least not economical, and their function can be far better accomplished in the reheater; the combined action of a high-pressure cylinder jacket and intermediate reheater may reduce the steam consumption at full load from 7 to 10 per cent, the percentage of saving increasing for lighter loads and diminishing for heavier loads, and being greater at high than at low pressures.

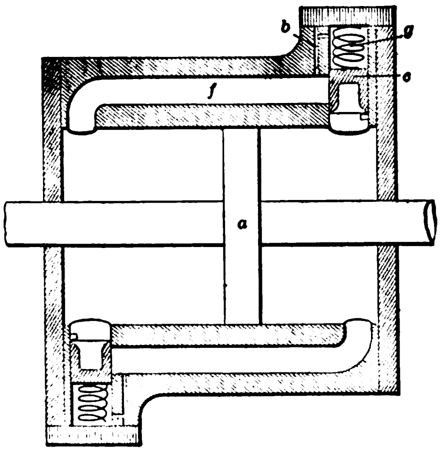


FIG. 27.—CROSS-SECTION OF DASH-POT.

The efficiency of jacketing, including in that term the reheater coils, is determined in part by the design and in part by the manner of using. High-pressure cylinders should have both heads as well as the barrel jacketed; the reheating coils should have sufficient surface area to evaporate all the water of condensation and slightly superheat the receiver steam at full load, when the moisture in the steam entering the high-pressure cylinder does not exceed 1½ to 2 per cent; the receiver must have ample capacity; steam for the jackets must be wholly independent of the steam used in the cylinders; the circulation of jacket steam must be rapid and constant; the condensation in jackets must be returned to the boilers. All of these canons are simple and almost self-evident, but they are nevertheless constantly violated with resulting loss of economy and condemnation of the system; jacket pipes are reduced in area, reheating coils have insufficient surface, receivers are too small, condensation is allowed to collect in the coils or is discharged to waste, and the active circulation of jacket steam is not maintained.

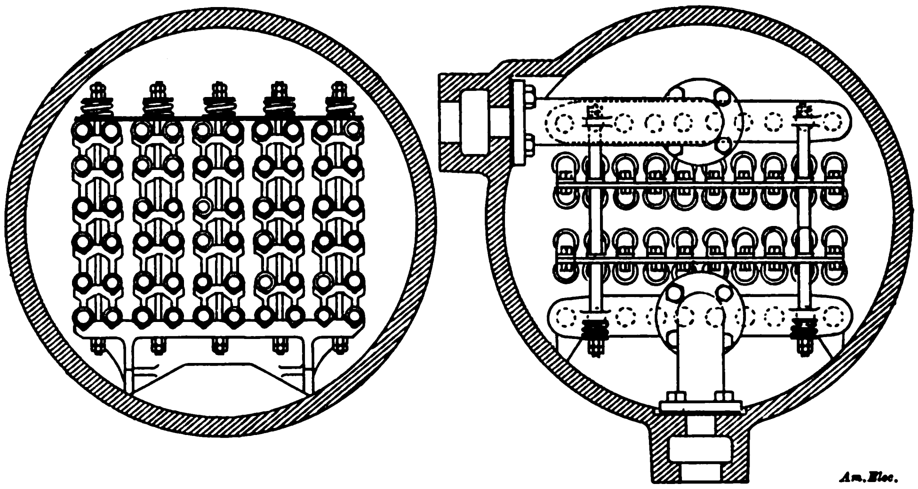


FIG. 26.—CROSS-SECTIONS OF THE REHEATING RECEIVER SHOWN BY FIG. 24.

An excellent example of reheater construction for a vertical engine is shown in Fig. 24. The receiver is sufficiently large to allow the exhaust from the high-pressure cylinder to traverse the tubes slowly, the brass tubes are inclined to insure drainage, one-third of a square foot of heating surface is allowed per rated engine horse-power, the tubes are held sufficiently tight to prevent jarring and wear from the pulsations of the steam, but with sufficient flexibility to prevent strains from expansion and contraction. The arrangement of ferrules, clamps and springs by which this is accomplished is plainly shown in the sectional views, Figs. 25 and 26.

The rapid growth of the alternating-current system has brought prominently to the front the problem of parallel operation. Generally speaking, parallel operation becomes important in proportion as the number and size of units increase; with a large system economy in the use of copper, the proper division of circuits, and the convenient and economical operation of the power plant make it a necessity. In their attitude toward this problem we have a good example of the lethargy and lack of initiative among engine builders in general, referred to at the beginning of this paper. For four or five years dynamo builders have continuously exerted a considerable pressure on engine builders in an effort to get them to devise a means for controlling the engine speed independent of the throttle, and for suppressing cross currents due to a synchronous action between the governor and the cross currents by which the currents are maintained and sometimes increased.

Under this stimulus one engine builder has promptly attacked the problem and has developed a highly efficient speed-changing device controlled at the board by the switchboard attendant, who has entire control of the engine speed within certain limits, and who can connect units in parallel, disconnect them, or divide the load in any desired proportions between two or more units operating in parallel without affecting in the slightest degree the sensitiveness of the governor or its capacity for regulation, or interfering with the duties or responsibilities of the operating engineer. The same manufacturer has developed, for preventing the synchronous inter-action of governor and cross currents, a special form of dash-pot with by-passes controlled by valves having a time element in their movement; this dash-pot is illustrated by Fig. 27. With a fixed load and the governor quiet, no pressure is exerted in either direction upon the oil with which the dash-pot is filled, but if the load changes, the governor weight tends to move, thus exerting a pressure on the by-pass valve through the medium of the oil. If the load is of very short duration, as is the case with cross currents, the effort of the weight to change its position does not persist for a sufficient length of time to open the by-pass valve, the piston in the dash-pot, and consequently the governor weight, is prevented from moving and the average engine speed remains unchanged; on the other hand, if there is a legitimate change of load the effort of the weight to change its position persists, the by-pass valve opens, giving a free passage to the oil, and leaving the governor perfectly free to move to the new position required by the change in load. The time required for the full opening of the by-pass valve is so short that the sensitiveness and accuracy of the governor are unimpaired.

One or two other builders are at work on devices to accomplish the same results, but they are as yet in the experimental stage, and owing to the possible effect on patent applications, details are not available for publication. The majority of builders, however, adhere to their established practice, so that dynamo builders are, in many instances, reduced to the crude, uneconomical and inefficient expedient of advising, in order to suppress cross currents, a degree of regulation that would not be tolerated with direct-current apparatus, while the division of load is largely left to take care of itself.

The question of cylinder ratios still continues to be discussed, but without definite progress; the final decision must rest on practical results, and thus far results prove nothing, as equally good results can be cited with widely different ratios. Until there is a decided preponderance of evidence in favor of a change it is probable that the present moderate ratios of 1:4 or 1:4½ for pressures of 130 to 150 lbs. will be adhered to by conservative builders, as there are certain mechanical disadvantages in the higher ratios.

The subject of highly-superheated steam is attracting increased attention which will undoubtedly be followed by an increase in its practical application. That there is an economy in the use of superheated steam is well established, but whether there is the degree of economy claimed by some of its extreme advocates may be doubted. The literature extant is confined mostly to tests on single engines under fixed conditions, while its real value must be determined by the results obtained for the entire plant, under the regular running conditions, and taking into account total operating expenses and not merely steam or coal. There is very little authentic data, especially in large sizes, with respect to its use in engines with the high rotative and piston speeds now being adopted; rod packings have not been developed in this country to a point where they are guaranteed under more than very moderate degrees of superheat; few operating engineers have had any experience in its control, use and dangers; and there remains much to be learned with respect to its effect on auxiliary apparatus.

At the present time it is entirely feasible so to design a plant that a degree of superheat may be added sufficient to prevent initial condensation in the high-pressure cylinder, relying on the intermediate reheater for the additional superheat required by the low-pressure cylinder; the knowledge gained from a few stations operated under this condition will form a sure foundation for further experiments; in the present state of actual knowledge the wisdom of the suggestion which has been made to add at the beginning superheat sufficient to carry the steam dry through both cylinders is, at least, doubtful.

The economy in steam consumption obtainable from well designed compound engines is so close to the economy of triple-expansion engines that the difference is usually offset by counter charges for interest on the increase in first cost, the increase in maintenance, and the cost of the additional floor space required; there is also the practical objection of the diminished overload capacity of the triple.

The descriptions and illustrations throughout this article have referred almost exclusively to horizontal engines. The reason is solely that the horizontal type has offered a wider range of examples and practice than the vertical, and it is not to be inferred that the former possesses any inherent advantages over the latter; in fact, most of the subject matter may apply equally well to both. There is one type of engine that is most suitable for a given set of conditions, but the type must be subordinated to the conditions and not the conditions to the type; therefore, the engine should be horizontal or vertical, simple, compound or triple-expansion, high-speed, moderate-speed or slow-speed, as the conditions dictate.

A HINT FOR PRACTICAL ENGINEERS.

BY WILLIAM D. ENNIS, M. E.

The purely practical man in the central station works under one disadvantage; when a proposed line of improvement is suggested to him he has just two sources of information to fall back on. One is his good judgment, the other his experience. He may have plenty of both, and yet be compelled to say "I don't know" when he is asked whether doing this or not doing that will save coal. To illustrate: A thoroughly competent man is in charge of the steam plant, say, of a large department store. He carries steam at both high and low pressure for heating, restaurant and elevators. The owners decide to install a lighting plant. How is he to know and prove whether it will be best to purchase cheap simple engines and supply the low-pressure mains with exhaust steam, or to put in expensive and highly economical compound-condensing units? One manufacturer of steam engines advises the first course, another advocates a precisely opposite procedure. It is a question of calculation. The engineer needs all the theory that is in him or that he can invoke, and even then he must be extremely careful, unprejudiced and conservative in his estimates.

He may be contemplating the purchase of a feed-water heater. One manufacturer guarantees to produce a temperature of 212°, another of 160°. Both are apparently reliable people. What is the buyer to do, unless from the quantities and pressures of steam and water and the design of the heater he can calculate which of the two bidders is naming a reasonable efficiency? If he is sufficiently good at figures to work out the problem, he has still to convince his employer that he is right and the sanguine manufacturer wrong. What is wanted in the great modern central station engine room, such as those of the Metropolitan and the Manhattan systems in New York City, is the man who is able to think in B. T. U. or to stop a Corliss engine without getting it on center; to analyze flue gases or to show a new fireman how to wash a boiler; to calculate clearance volumes or to oil an eccentric. He must, and can, be a master of the machinery he handles, knowing not only what it does but why.

The fundamental idea that must be mastered by every engineer who wants to handle steam engineering problems is that of the difference between heat and temperature. Temperature is nothing more than a measure of quality or intensity of heat, and has very little to do with quantity. A pound of water and a pound of steam may both be at a temperature of 300°; but the latter contains four times as much heat as the former. Put the pound of water into a tank and mix it with a pound of comparatively cold water, say at 100°; the final temperature will be about 200°; but mix the pound of steam with a pound of water at 100° and the resulting temperature will be above the boiling point.

The amount of heat contained in a substance depends upon its temperature, weight and specific heat. The specific heat is the amount of heat that would be set free by one pound of the given substance while cooling one degree Fahrenheit. It is measured by comparing it with the amount of heat that would be set free by water under the same conditions. The specific heat of water is considered to be 1. That of liquid ammonia is 1.02 times that of water, the heat unit being a measure of quantity of heat. In heating 10 pounds of water from 20° to 120°, the temperature is raised 100 degrees, and there will be required, therefore, $10 \times 100 \times 1$ heat units, or 1000. The same quantity of liquid ammonia heated through the same range of temperature would require 1,020 heat units, approximately.

The ordinary steam table, as given in all handbooks and manuals on steam engineering, consists of a number of columns. The fourth column of the table usually gives in heat units the quantity of heat in boiling water at the pressure stated in the second column. This is measured above 32° Fahr., and is, for each pound of water, equal to the temperature in degrees less 32 (practically). The fifth column gives the quantity of heat in steam at the stated pressure. This is equal to that given in column 4, plus what is known as the "latent heat of evaporation," and which is tabulated in column 6. These values represent the amount of heat which must be provided to evaporate water after it has been raised in temperature to the boiling point; the same amount being set free in the condensation of steam without loss of temperature. Upon this point—the large quantity of heat imparted or lost without any change whatever in temperature—hinges all computations of efficiency of feed-water heaters.

An illustration will plainly show the wide application of the steam table to practical uses. In a certain power plant there were in use two feed-water heaters. The main heater was connected in the exhaust pipe of a condensing engine; the small heater received several pump and condenser exhausts. The feed-water passed first to the large and then to the small heater, on its way to the boilers. After the plant had been operated for some time a new engine and condenser were purchased. Some original genius conceived the idea of piping from the small heater to the new condenser in order to get the benefit of a vacuum on the small exhausts. The feed-water after passing the second heater, instead of being at a temperature of 192° as before, dropped to 137°. The explanation was not far to seek. The vacuum of the main engine and original condenser was 24 inches. The temperature, according to the steam table, was therefore about 141½°. This was the highest possible temperature that could be imparted to the feed water at this point by means of a closed heater. The new condenser maintained a vacuum of 26 inches, and a temperature, consequently, of 126°. Instead of being a feed-water-heater, the second heater was therefore a feed-water cooler, and was actually chilling the water as it came from the first heater. This could have been avoided by the use of a little "theory."

As an illustration of an opposite tendency, an eminent consulting engineer—one whose name is often quoted as authority—was once inspecting a large mill plant in company with the president of the manufacturing corporation. The man in charge of the engines was called from the room. The piston-rod gland of the main engine began to let steam through. The president noticed it and knew enough to realize that the engine needed a little cylinder oil. The scientist saw, too, almost at the same minute, that the lubricator was nearly empty. Neither of them knew how to fill or adjust it, although the oil can stood on the cylinder lagging close by. The consequence was that when the practical man came back and pumped a little oil into the cylinder through the hand cup, neither of the two had enough dignity at call to reprove him for his negligence.

A FEW COMMON BOILER TROUBLES.

BY R. A. DOUGLASS.

Blisters.—Blisters often appear on the plates of a boiler after the boiler has been in service a short time. Formerly, when iron plate was used in boiler construction, it might be said to be exceptional to find a boiler that had been in use for some time without showing, somewhere, evidences of a blister. This was because the mode of manufacture of the iron tended to produce a laminated product, of such a character that a part of the plate could easily separate from the rest of it. If at some point the various layers of plate were not firmly united to one another, the heat-conducting power of the plate would be materially lessened where the layers were not firmly united, and the result would be that the outer layers could become so much overheated as to soften and bulge outward. Now that steel is used so commonly in the manufacture of boilers, it is rare to find a blistered or laminated plate, although occasionally they do occur. Blisters, in most cases, are harmless, as they cover only a small area. A blister on the heating surface can be best treated by chipping off the projecting part so as to leave a clean surface of the sound plate exposed to the fire. Unless the blister is very large in extent, it is not wise to cut out the part of the plate in which it occurs. Many a boiler has had its strength materially reduced by having part of the plate cut out in this way and replaced by a single riveted patch, when the other seams of the boiler were double riveted.

Fire-cracks.—These are cracks extending from the edge of the plate to the rivet holes. On the horizontal tubular type of boiler they are found chiefly on the girth seams over the furnace, and in internally fired boilers any of the joints in the fire box may show them. (The inner side of the door is liable to be attacked also.) In most cases fire-cracks do not leak unless they extend past the rivet hole. In this case a half-inch hole should be drilled at the end of the crack, and a stud-bolt screwed into it. This will stop the leakage and prevent a further extension of the crack. Fire-cracks are due to several causes. Thus they are especially likely to appear when the material composing the plate is hard, and does not possess a proper degree of ductility. Again, the plate may have been injured in the construction of the boiler, by the careless use of the drift-pin. Poor management of the fire doors is also responsible to a considerable extent; for when the fire doors are thrown open while a hot fire is burning, so as to allow the cold air from the outside to strike directly against the heated plates, a sudden contraction of the material results, and this is likely to be followed not only by fire-cracks, but also by leakage at the seams in general, or at the tube ends in the rear head. Care should always be taken to avoid all unnecessary admission of cold air against the plates when the boiler is under steam.

Oil.—When heavy lubricating oils, or oils of any sort that leave a considerable residue upon evaporation, find admission to a boiler, it is almost certain that defects will sooner or later make their appearance, and be followed by an extensive bill for repairs. The commonest way for oil to get into a boiler is by being pumped into it together with the drips from a system where exhaust steam is used for heating, and the water of condensation is returned to a receiver. In all systems of this kind an oil separator should be used, and the drip from this should be carried to a sewer. (The writer remembers a case in which the drip from the separator was led into the receiver instead of the sewer, so that the oil passed into the receiver even more directly than it would have done had there been no separator present. The boilers at this plant were nearly ruined in a very short time.) In some cases the exhaust pipe from the engine may be provided with a separator, and yet the receiver may receive the returns from one or more pumps, each of which contributes a certain amount of oil. Oil also gets into the feed-water in connection with condensing engines, when the condenser water taken from the hot well is used as part of the feed. It is impossible to prevent oil from getting into the boiler when feed-water is taken from this source. The importance of excluding oil absolutely from boilers can hardly be understood by those who have not seen the damaging effects that may result from the admission of even a small quantity of it.

Pitting.—Pitting in boilers or piping is usually observed where the water is kept for a considerable time at a temperature somewhat below 212 degrees. The boilers that are mostly affected by this sort of trouble are those that are used for heating; and in these it is observed chiefly in the fall and spring, when the boilers are used only a part of the time. At such times pitting is likely to be very marked, and it is nothing unusual to see a set of tubes used up in two or three years. In an instance that came under my observation, a new boiler was put into service, for power, in the month of December, being used in connection with five others. Business becoming slack at this factory about the time the new boiler was installed, only three of the available six boilers were needed at any one time. The practice was to use three of the boilers for two weeks, and then to allow these three to stand idle for two weeks, without emptying them. In the following August three of the tubes in the new boiler gave out. Upon examination it was found that the tubes in this boiler were all badly pitted. The three that had given out were replaced with new tubes, and the boiler was thoroughly boiled with soda ash. Two more tubes gave way during this process, and were replaced.

The battery was then put in use again under the same conditions as before, except that every boiler was now emptied when not in service. This occurred eight years ago, and the tubes are still in good condition. The tubes in the older boilers were not affected, as they were covered with a film of scale which protected them. To protect boilers in which pitting takes place the writer would advise that about 10 lbs. of lime be slacked and put in each boiler. This will cause the formation of a thin lime scale which will prevent pitting for a time. When this thin protective coating is dissolved away, the operation should be repeated. Of course this treatment is not recommended for a boiler is which there is already a plentiful supply of scale. This would naturally be understood, because it is not in these boilers that pitting occurs. Still, it may be as well to speak of this point explicitly, in order to avoid misunderstanding.

THE CHOICE OF A PHOTOMETER FOR CENTRAL STATIONS.

BY WILBUR M. STINE.

It is well for those who have but a slight knowledge of the matter and the practice of photometry to realize that the measurement of the luminous properties of light is far from being in the state of an exact science in which invariably accurate rules and laws may be stated. The chief reason for this condition of the subject, is that photometry is devoted to the action of light which affects the eye in giving rise to the acts of vision. The apparatus for photometrical measurements is thus of a different character from the exact instruments for the measurement of the properties of electricity.

At the outset then, it must be realized that the selection of an appropriate photometer, is a matter to be decided by the suggestion of some one who is sufficiently experienced in such measurements to weigh the relative merits of the different forms of photometers now on the market. The requirements of each particular case would thus be considered and a recommendation made of the type of instrument which would best meet them. In a general way, however, some suggestions may be given in an article like the present one, which will prove helpful, even if they are not adequate for a final selection of the particular instrument.

The first step toward an intelligent choice of an apparatus is to consider the commercial photometers made and sold in this country, under two classes. In one class will fall the photometers made by several firms of established instrument makers, who are sufficiently familiar with the state of the art to know the requirements of its practice, and who have carefully designed apparatus to meet such requirements.

Under the second class must be placed the photometers which are made by firms who do not manufacture high-grade apparatus, either from the standpoint of design or construction. Such instruments are usually given considerable exterior finish, but in their essential parts they are in a large measure worthless. A finely-polished brass case and a neat plate glass cover do not necessarily imply that a voltmeter, for instance, which they cover, is reliable. The essential parts of such apparatus, the soul of the thing, if one may be permitted the expression, is so neglected in design and construction, that the instrument is a delusion and a cheat. No amount of polished mahogany, nor array of bellows, and display of poor scales, can make a good photometer.

There is at least one type of photometer on the market which, from the standpoint of manufacture, is undoubtedly entitled to confidence on the part of at least one of its makers. However, from the considerations of its design this apparatus is to be avoided. This type employs a kerosene lamp for a secondary or comparison standard. A standardized incandescent lamp is usually provided in order to calibrate the oil flame; and when this is so done, the photometer is supposed to be ready for action. If the reasons for the condemnation of the petroleum flame as a standard of light were to be set forth at large, it would require more space than the present article can be given. But briefly, the color of the flame, and more especially its inconstancy, unfit it for such use. Even in the hands of a skilled photometrician, the petroleum flame is unsuited for use as a working standard; and it is especially unsuitable for those who simply make occasional photometrical measurements.

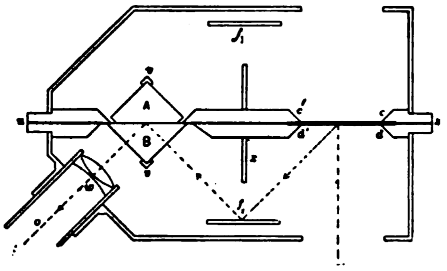


FIG. 1.—BUNSEN SIGHT BOX.

Returning to the consideration of the first class of photometers, which are well made and correct in design, they may be divided into two groups for the present discussion. To the first group belong a few photometers of an especially compact and self-contained design. This type has mounted on a base-board with suitable ways, the supports for the tested and standard lamps, the rheostats for the control of the voltage, and the connections for wattmeter and voltmeters. The essential feature of the apparatus is a Bunsen sight-box; and the whole train of optical fixtures is fitted into a bellows for the exclusion of extraneous light. These instruments may be distinguished by the term "portable," and they have their own sphere of usefulness. They should always be used with a rated incandescent lamp for the working standard of light; and as a rule they are suitable only for the photometry of incandescent lamps. But they may profitably be used to a limited extent in arc lamp photometry. An enclosed-arc lamp giving a rather yellow color of light may be successfully photometered for horizontal candle-power with the use of such apparatus. These portable photometers are to be recommended for general central-station use, and they have the added merit that they do not require an especially fitted dark room; and being comparatively inexpensive, they are admirably adapted for extending photometrical measurements into general station practice.

The second group of accredited photometers comprises those which are designed for the careful and exact measurement of light. Whether they are made by one maker or another, they are closely similar in their general design. They consist in the first place of a *bank*, which is merely a mechanical device for mounting the essential parts of the photometer. The entire group has been modeled over the photometer devised in the German Imperial Physical Institute, or the Reichsanstalt. This type, by reason of the simplicity of its design and its satisfactory character, has been adopted by all the leading American makers.

The bank consists of two parallel ways, usually cylindrical, which serve as a track for the essential parts of the photometer. This track is variously framed and stiffened, and is mounted either on a table or a pair of pedestals. Both a proportional and a candle-power scale should be engraved on the track. When the photometer is to be used for incandescent-lamp testing, the bank is equipped with the lamp holders and the sight box. In addition there should be auxiliary devices for spinning the lamp under test, and rheostats for the control of the voltage; and preferably an universal holder for measuring the candle-power at any angle of inclination. Canopies may be fitted to the track for excluding extraneous light, or the measurements may be carried out in a suitable dark room.

The sight box contains the photometer proper, or the light measuring screen; all the other details and fittings are auxiliary in their relation to this member. There are now but two types of sight box used with this Reichsanstalt photometer, one is the so-called "optical" or the Lummer-Brodhun screen; and the second is the well-known Bunsen screen. We will raise the question, which shall be selected?

It will be assumed that extensive and exact measurements are to be made, and measurements of a more varied character than can be carried out with an instrument of the portable type. A well equipped Reichsanstalt bank is then the only photometer to be considered. Regarding the details of its equipment, the nature of the sight box must be considered.

The essential parts of the Lummer-Brodhun box are shown in plan in Fig. 1, where *A* and *B* are two glass prisms which are firmly clamped together on their hypothenusal faces. One of the prisms is slightly cut out on this face, over two small rectangular or other areas, according to the designed shape of the sight field. The axis, *uz*, of the sight box is set at right angles to the axis of the lamps, or what should be the same thing, to the axis of the bank. A white screen, *cc'*, *dd'*, reflects the light from each lamp respectively to the mirrors, f_1 and f_2, and these in turn reflect it to the prisms, *A* and *B*. The cut-out areas are shown in section in Fig. 2, and if in this figure the prism, *abd*, is taken to represent the prism, *A*, of the first figure, it will be seen that the light from the lamp on the left end of the bank, after being reflected from the screen, *cc'*, and the mirror, f_1, will pass through the portions of the face of the prism, *A*, marked 2 and 4 in Fig. 2; and thence it will pass to the observing telescope, *ow*, and appear to the eye as the parts 2 and 4 of the sight field shown on the right of the second figure. The light, however, falling on the areas, 1 and 3, of the hypothenusal face of the prism, *A*, will be totally reflected and not enter the telescope or appear in the sight field.

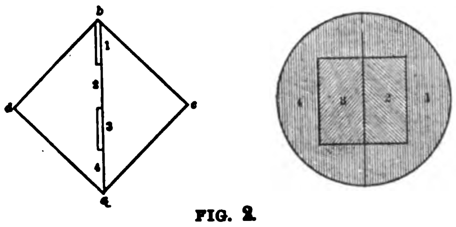


FIG. 2.

The light coming from the lamp on the right-hand end of the bank will be reflected from the side, *dd'*, of the white screen, and the mirror, f_2, to the prism, *B*, of Fig. 1, or *acb* of Fig. 2. The portion of the light falling on the areas marked 1 and 3 will be totally reflected and pass on to the telescope, *ow*, and appear in the sight field as the portions marked 1 and 3. Also the light falling on the areas marked 2 and 4 of the prism will pass on unchanged in direction and not enter the telescope.

The sight field will now be lighted, one-half by the lamp to the right and the other half by the lamp to the left. Precisely, the areas 1 and 3 will be lighted by the lamp to the right, and the areas 2 and 4 by that to the left. In the ordinary use of the sight box, the aim is to bring the two pairs of areas into an equality of illumination, when, if the compared lights are of exactly the same tint, the sight field will appear uniformly lighted. It is perhaps gratuitous to the reader to observe that such an apparatus is complicated in construction and adjustment, and may become perplexing in use.

Some of the advantages which may be advanced in favor of the complicated optical screen are that the plan of the sight field approaches very closely to the ideal requirements for the sensitiveness of adjustment between the illuminations compared, and that by the use of such an apparatus lights which differ considerably in color can be compared with some degree of certainty, and in consequence this screen is adapted to the photometry of arc lamps. The vital questions, however, to one who wishes to apply photometry to commercial and practical uses are: Does the optical screen satisfy these claims in practice, and is there no simpler apparatus which will yield sufficiently accurate results?

In answer to the first question just raised, it cannot be conceded by those experienced with the apparatus that such a screen does meet all the theoretical anticipations which follow from its design. The apparatus is faulty in a number of particulars, and does not in practice yield the high sensitiveness which its design would indicate. The Lummer-Brodhun screen, however, is an admirable instrument for the laboratory, and one that is valuable to the investigator; but it is scarcely advisable for the use of the mere practician.

Before proceeding further with the discussion of this question of practicability it is well to consider what sensitiveness is required in a photometer. Under the very best conditions the value of the standard light used is not accurate within 2 per cent, and the limit of uncertainty is rather apt to be double this value. For practical purposes this limits the sensitiveness required in the setting of the photometer. In the hands of one who is experienced with the Lummer-Brodhun photometer, the sensitiveness of the setting is perhaps many times as great as it need be, considering the unreliability of the standard of light.

Taking up now the second question, the Bunsen screen is about as simple a device for comparing the illuminating power of lights as could well be designed. For the comparison of the two types of screens, a sight box fitted with a Bunsen screen is shown in plan in Fig. 3. The screen is a sheet of paper, *sc*, with a transparent central spot. Two mirrors, *m* and *m'*, reflect the light from the screen to the observing tube, *o*.

The Netherlands Gas Commission, from a comparison of these two screens, found that the Bunsen screen was even more sensitive than the Lummer-Brodhun optical one; and this decision expresses the opinion of many who have had experience with both forms of apparatus. For exact practical photometry the Bunsen screen can be confidently recommended, and it will generally prove more exact and reliable than the more complicated optical screen. Besides, it is comparatively inexpensive and is easily kept in working order.

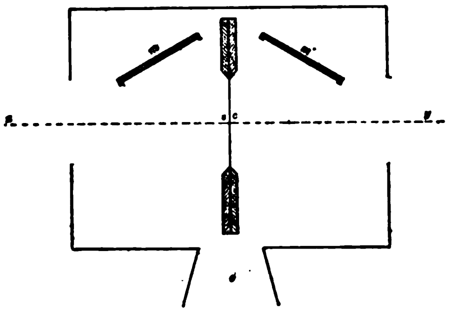


FIG. 3.

ELECTRICAL PROGRESS IN AUSTRALASIA.

BY LAWRENCE BIRKS.

The progress of electrical work in the new commonwealth is steady if not rapid, the tendency being to remodel existing plants on up-to-date lines. In Melbourne, Richmond, Bendigo, and other large cities, the old two-wire 110-volt plants are being scrapped in favor of large three-wire 440-volt systems. For this class of town lighting plant direct-coupled vertical enclosed high-speed engines are in favor, usually of the manufacture of Willans, Belliss or other well-known British builders.

Great developments in water-power schemes are promising in New Zealand and should be carefully watched by firms who are interested in selling the requisite apparatus. The city councils of Auckland, Dunedin, Gisbourne and Wellington have all obtained expert reports and are seeking Parliamentary powers to proceed with works costing from $250,000 to $750,000 each. In electric traction rapid progress is being made. Here, of course, American apparatus holds its own. In Sydney, N. S. W., the present government traction station, equipped with four Allis-General Electric 850-kw. sets is taxed to its utmost and three more 1500-kw. three-phase 6600-volt units by the same makers are on order, together with equipment for five 1000-kw. sub-stations. A large number of smaller towns have tramway systems in hand. Messrs. Noyes Bros., representing the Westinghouse Company, being particularly active.

In power distribution there are three high-tension polyphase stations in operation in Victoria for supplying gold dredging barges with power for pumping, the plant in two of them being American, in the third local. The Kalgoorlie (W. A.) Electric Power Company, which is slowly maturing its plans, promises to supply the mines of that district with an up-to-date system, but there is still a large and almost untouched field in Australian mining for electrical development.

With the introduction of electric power to the larger cities the possibilities of electric elevators are beginning to be recognized, and some three or four have been installed from the Sprague and Otis factories. But there is a big prejudice among the architects to be overcome. Good illustrated catalogues will go a long way in removing this prejudice.

Australian engineering firms have their possibilities fully taxed to supply the demands of the mining and hydraulic industries which are more or less peculiar to the districts. In electrical equipment standard imported lines will prove far more satisfactory than anything which can be manufactured here at present. The long time of mailing and delivery remains a great difficulty. This should be partially overcome as the demand becomes more steady and importing firms can carry larger stocks. For the present it can only be minimized by careful cataloguing.

TWO EXAMPLES OF MODERN AMERICAN CENTRAL STATIONS.

THE ATLANTIC AVENUE STATION OF THE BOSTON EDISON COMPANY.

BY ALTON D. ADAMS.

The history of the Edison Electric Illuminating Company of Boston is similar to that of all of the large Edison central stations. From a modest beginning, with two small bipolar dynamos and a high-speed simple engine under a single roof, of course, the plant has grown to a group of generating stations, the main one of which contains modern machinery in units any one of which has an ability that would have seemed absurdly superabundant when the plant was originated. The company now operates three generating stations and three storage-battery sub-stations. The particular subject of the present article is the Atlantic Avenue plant, which is known as the Third Division station, and has been recently very greatly enlarged.

The Atlantic Avenue station is located on the water front, at the foot of Pearl Street. The plan view given on page 278 indicates clearly the "lay-out." This station was established in 1891, when it was provided with seven Babcock & Wilcox water-tube boilers rated at 368 horse-power each; but space was allowed in the original boiler room for eight more boilers, each of equal capacity to the first. The length of the original boiler room parallel with the boiler fronts was 79 ft., but the extension just made to the station increases this length to about 203 ft. At first the brick setting of boilers was made continuous so that the boiler fronts presented an unbroken line, but the later additions of boilers have been set in pairs with an open passage from front to rear between the settings. One pair of boilers is equipped with Hawley down-draft furnaces.

The new equipment comprises eight double-deck Babcock & Wilcox water-tube boilers rated at 418 horse-power each. These boilers are equipped with Babcock & Wilcox chain grate stokers, 90 x 111 ins., providing a grate surface of 69.4 sq. ft. The stokers are driven by 7½-h.p. 220-volt motors, having a speed of 300 r.p.m., made by the Bullock Electric Manufacturing Company, of Cincinnati, Ohio. Each motor is geared to a jack shaft, having a speed of 70 r.p.m., which can be varied 12½ per cent above or below normal by means of a motor starting box.

There is an eccentric on the jack shaft with a rod connecting down to a rocker arm carrying a pawl, which engages a toothed wheel driving a worm, which in turn drives a gear fastened to the main sprocket shaft of the grate. The ashes are discharged from the furnaces through chutes to the ash room below the boiler-room floor, and then carted away. On the water side of the space beneath the boilers two rooms are partitioned off, one for the circulating pumps and the other for the feed-water pumps.

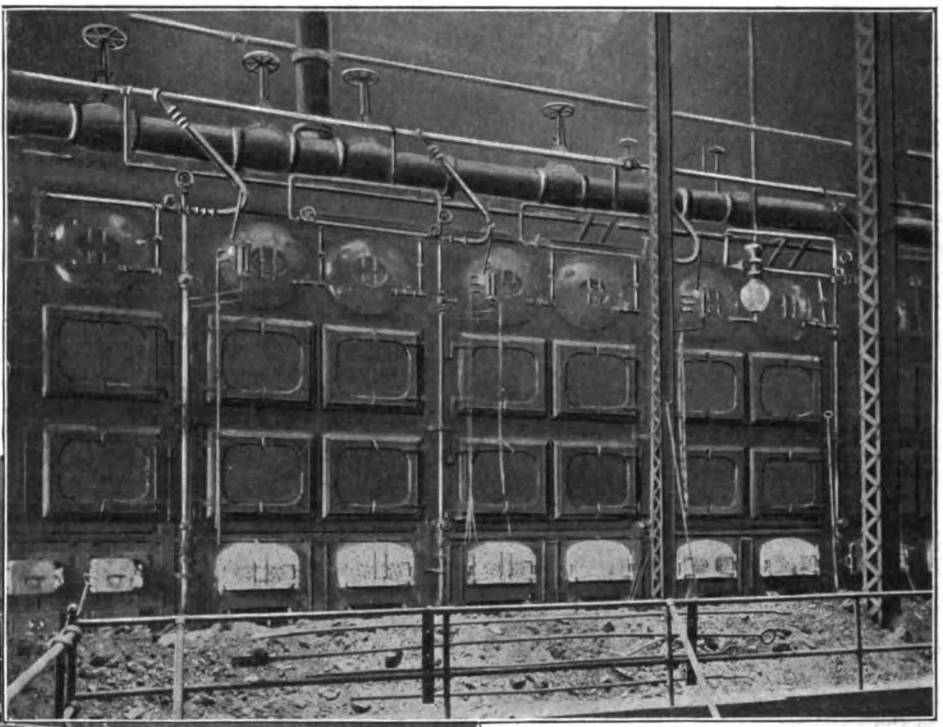


FIG. 2.—THE OLDER BOILERS.

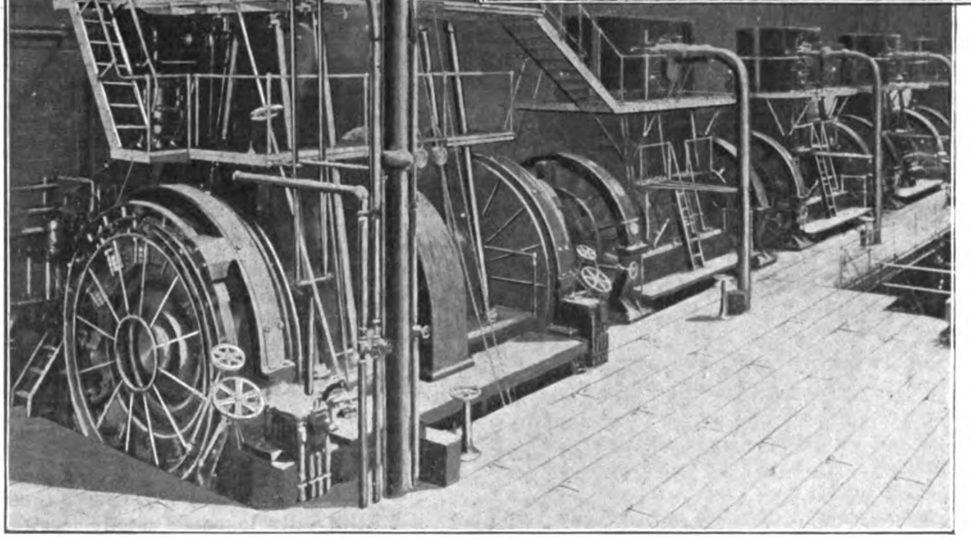


FIG. 1.—ONE SIDE OF THE OLD ENGINE ROOM.

The steam pressure of the boiler plant is 160 lbs., gauge. Natural draft was decided on, and a chimney erected of sufficient height to give the required draft and large enough to conduct the gases of 15 boilers like the first seven. This chimney is 200 ft. high, 11 ft. 5 ins. in internal diameter, while the top diameter outside is 18 ft. at the base and 14 ft. 6 ins. at the top. The outside wall of this chimney starts with a thickness of 20 ins., changes to 16 ins. at about 70 ft. from the base, and again to 12 ins. at about 140 ft., retaining this thickness to the top. The inside core of the chimney is 12 ins. thick at the bottom and to a height of 80 ft., where it changes to 8 ins., retaining this thickness to the top. The core is lined with fire brick to a height of 25 ft. from the base.

A second chimney has been added which is similar to the first one above the roof of the boiler house. The new chimney is octagonal from its base to a height of 55 ft., the outside diameter being 20 ft. between parallel faces. For the rest of the distance it is circular in shape, having a diameter of 14 ft. 7 ins. just below the cap. At the base the outside shell is 24 ins. thick, and the inside shell 16 ins., leaving an air space of 11 ins. between the two. The inside shell extends to a height of 135 ft., is 8 ins. thick at the top, and is lined with fire brick for 55 ft. of this distance. The outside shell is 12 ins. just under the cap. The inside diameter of the flue is 11 ft. 5 ins.

There are three M. T. Davidson compound tandem, non-condensing circulating pumps which supply the surface condensers with water from the harbor; the water ends being lined with composition metal to prevent any action of the salt water on the pipes. Two of the pumps have steam cylinders of 10-in. and 20-in. diameters, water cylinders 20 ins. in diameter and 24-in. stroke, with 14-in. suction and discharge pipes. The other pump has steam cylinders 7 ins. and 14 ins. in diameter, with 14-in. water cylinders and a stroke of 16 ins. For boiler feeding there are two Davidson simple pumps, each having a steam cylinder 14 ins. in diameter and a water cylinder 8¼ ins. in diameter, with a stroke of 14 ins.; also two Blake vertical compound duplex pumps with steam cylinders 10 x 16 ins. in diameter, and water cylinders 8 ins. in diameter, having a 10-in. stroke. There are also installed and ready for use, if necessary, 10 Korting universal injectors.

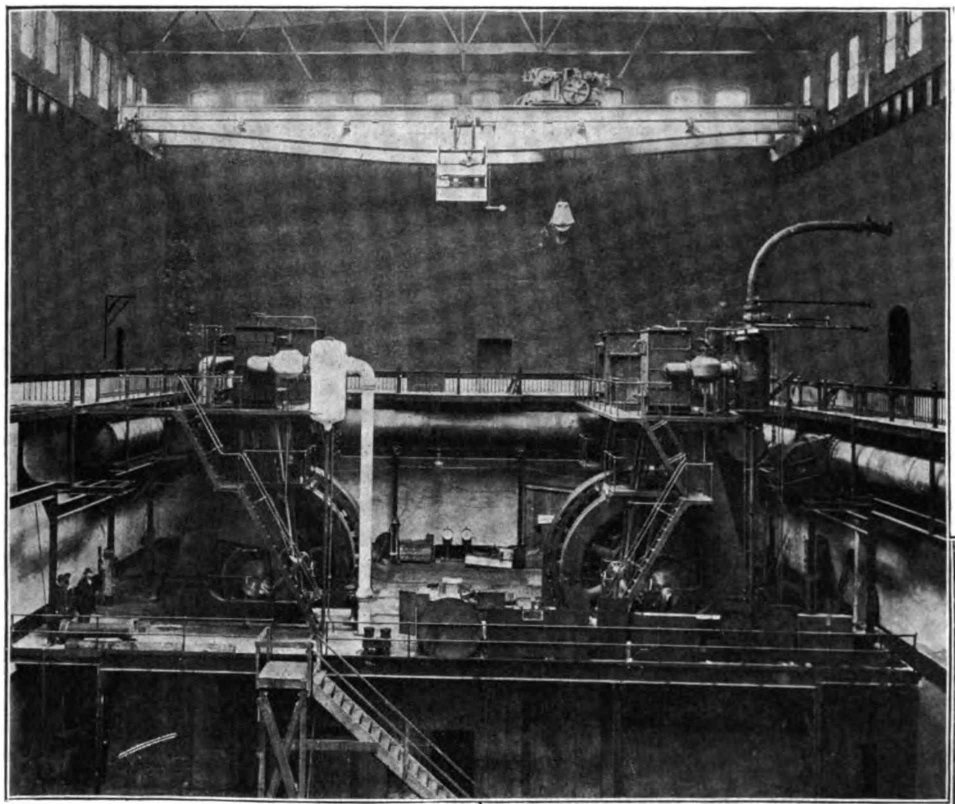


FIG. 3.—ONE END OF NEW ENGINE ROOM.

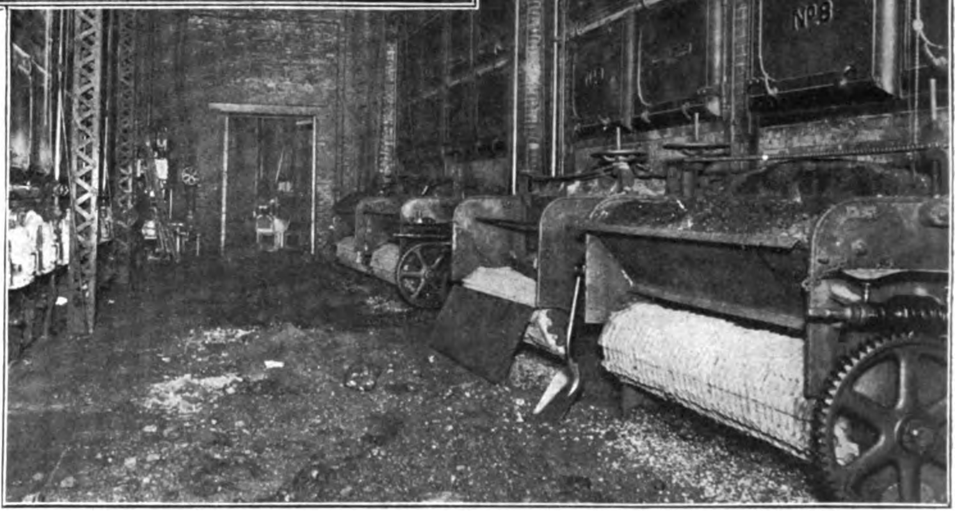


FIG. 4.—PARTIAL VIEW OF THE NEW BOILER PLANT.

Feed water for the boilers is taken directly from the city mains, the pipes in the street being so arranged that it would be almost impossible for the supply to fail. The main service pipe is 12 ins. in diameter, and delivers water under a pressure of 40 lbs. There is also a 12-in. high-pressure main which can be used in case of emergency. From the city mains the water flows through a Goubert exhaust steam feed-water heater, after which it passes into a Cochrane open heater, into which is turned the exhaust steam from all the auxiliaries; from this heater it is pumped into the boilers by the feed-water pumps. On the outside of the boiler room toward the wharf a space has been preserved for economizers, but at the time of writing they have not been installed. There is being drilled at the present time, just outside the boiler room, an artesian well which has already been sunk 500 ft., and if this well should supply the proper quality of water it will be used as a partial supply for the boilers.

The old engine room originally contained four triple-expansion engines rated at 650 horse-power each and built by the J. Morton Poole Company, Wilmington, Del., after designs supplied by the Edison General Electric Company. Each of these is provided with a Wheeler surface condenser and a combined air and circulating pump, these latter in each case being mounted on a cast-iron drip pan close to the engine base. The first addition to the plant was a McIntosh & Seymour cross-compound vertical engine, capable of developing 1200 horse-power under 160 lbs. steam pressure, and running at 100 r.p.m.

This engine has a combined reheater and receiver between the high and low-pressure cylinders, and also has a surface condenser and pump similar to those of the four smaller engines. The head and barrel of the high-pressure cylinder of this engine are jacketed, but not so the low-pressure cylinder. The guaranteed water consumption, including steam condensed in jackets and receiver coils, is 13¼ lbs. per hour per indicated horse-power. Both cylinders are four-ported, and are provided with valves of the flat gridiron type. The clearance is 2 per cent in the high-pressure cylinder and 3 per cent in the low-pressure. All four of the valves are driven by an eccentric controlling the admission of steam and the opening and closing of the exhaust. The cut-off of the steam is effected by separate cut-off valves which are driven by an individual eccentric and regulated by a shaft governor.

The valve gear is positive, composed of simple levers and links, and the cut-off can take place at any point between zero and the maximum cut-off. The piston rods of both cylinders are furnished with "Tripp" metallic packing, and are also provided with auxiliary glands for the use of soft packing. The throttle valve is a quick-opening valve of the double-poppet balanced type, operated from the floor-level by an operating wheel provided with a crank handle. The main steam pipe to the engine is fitted with an 8-in. "Direct" separator.

These five engines have two direct-current dynamos mounted one on each end of the shaft, but this practice was abandoned on the engines next installed, in favor of a single dynamo for each engine, mounted on the shaft between the parts

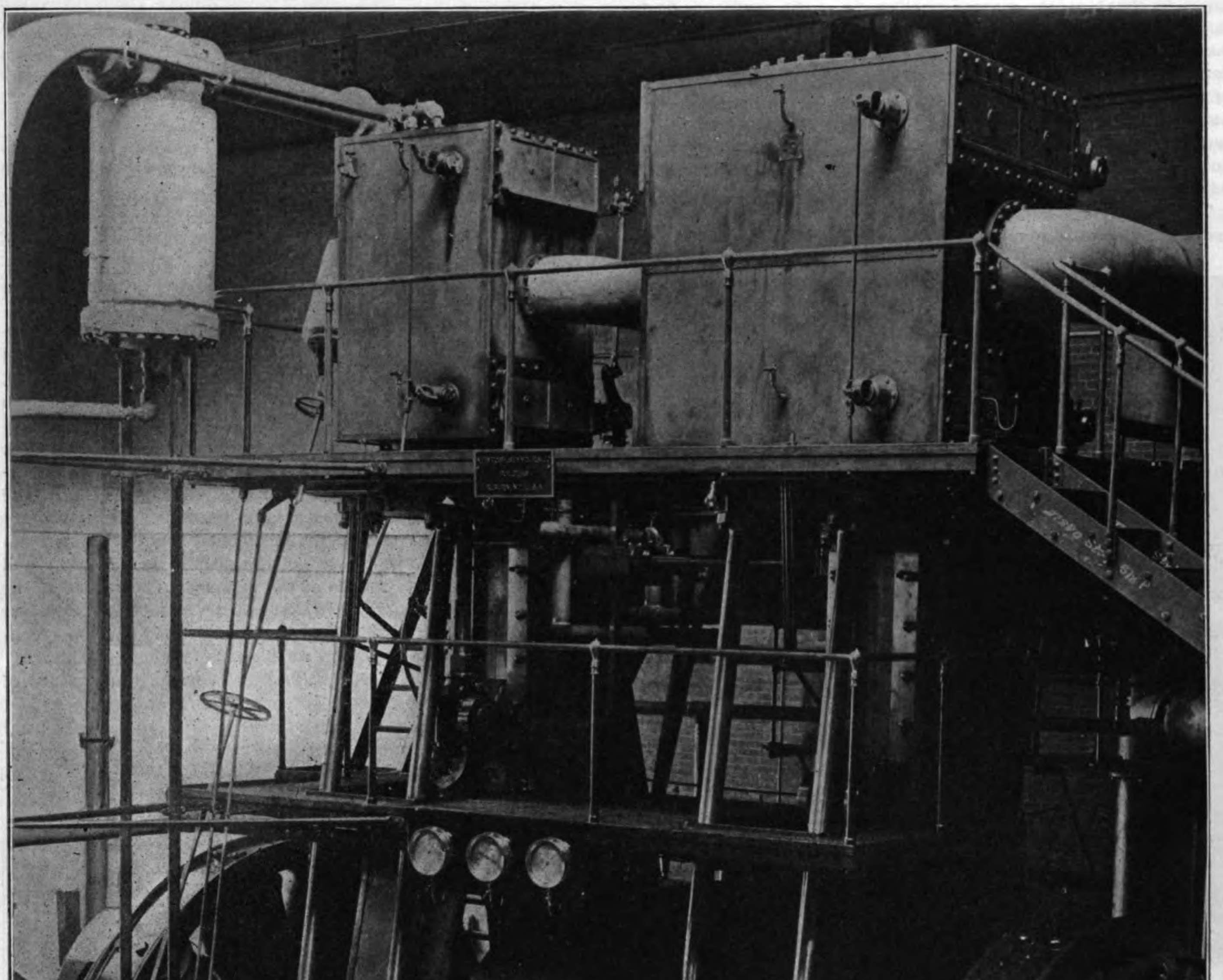


FIG. 5.—CROSS-COMPOUND ENGINE DRIVING TWO 400-KW. 110-VOLT DYNAMOS.

of the frame that support the high and low-pressure cylinders in each case.

The sixth and seventh engines to be installed were both of the McIntosh & Seymour make, and are capable of 1200 horse-power each at 160 lbs. steam pressure, running at 100 r.p.m. Each engine is guaranteed to regulate from no load to full-rated load within 2 per cent speed variation, and to develop an indicated horse-power, when running at full load, with a consumption of 13¼ lbs. of dry steam an hour. The cylinders and steam chests are lagged with magnesia fiber and sheet steel. Between the two cylinders is located a reheater containing about 440 sq. ft. of heating surface supplied with steam at boiler pressure. The cylinders are four-ported and provided with standard flat gridiron valves. The high-pressure cylinder has a clearance of 2 per cent, the low-pressure 3 per cent. The valve gears and governors are of the same type as the fifth one previously described. The bearings are hollow and provided for the circulation of water. They are also provided each with two sight-feed oil cups in addition to the oil which is supplied to the bearings by means of a brass oil pump driven from the valve gear. The crank pins, cross-head pins, guides and wipers are oiled continuously by means of a supply tank situated upon the upper plat-

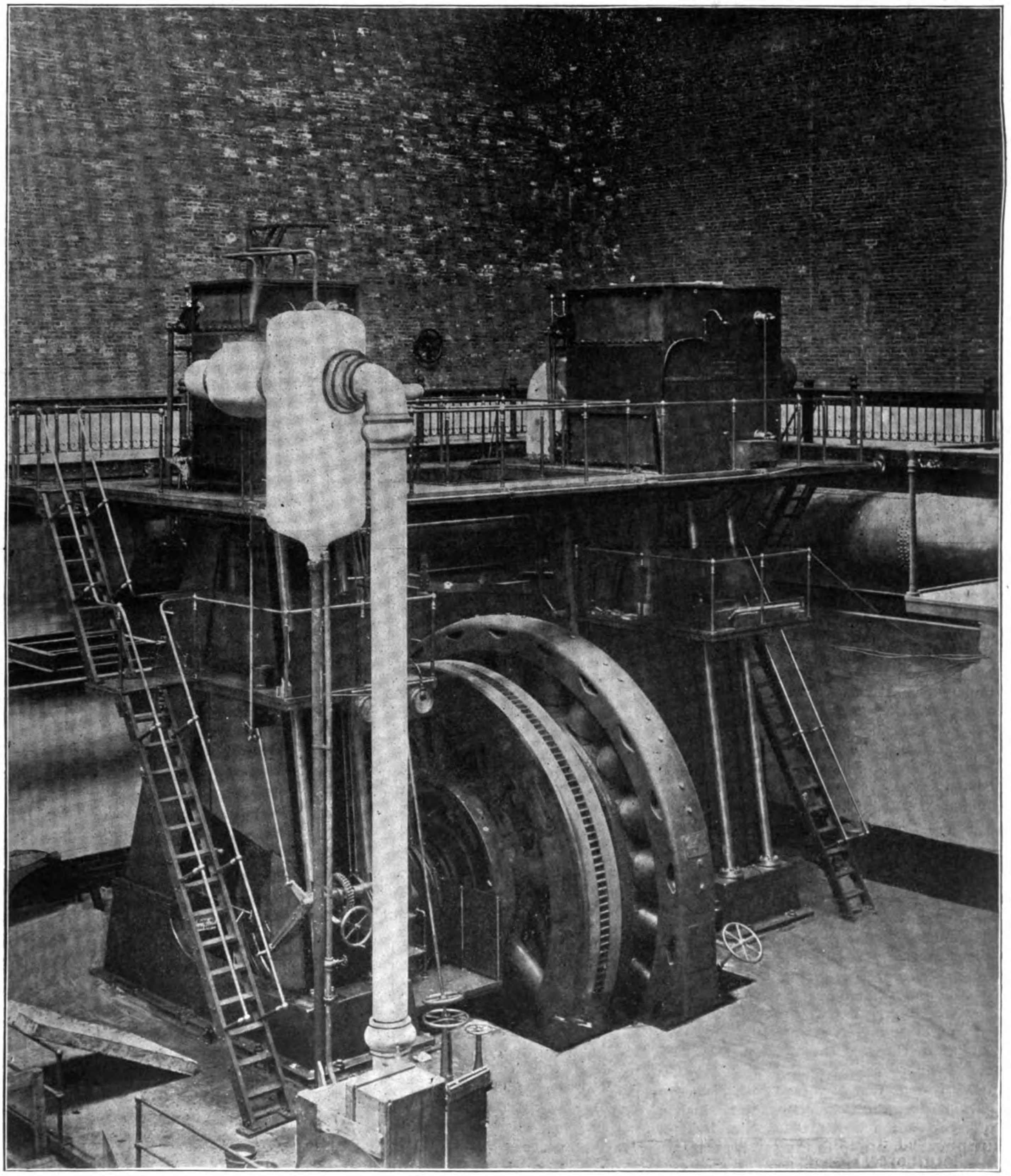


FIG. 6.—THE LATEST CROSS-COMPOUND ENGINE, DRIVING AN 800-KW., 300-VOLT DYNAMO.

form connected by a system of brass piping to an adjustable sight-feed outlet to each part to be lubricated. The engines are equipped with Cochrane receiver separators and have throttle valves of the quick opening piston type.

Both engines are provided with pumps and a condenser, as in the case of the other five. Cooling water for the condensers of all the seven engines thus far mentioned (which are all in the old engine room) is taken from the harbor underneath the wharf at the rear of the station. This water is conveyed to the condensers by a common suction main and is rejected through a common discharge pipe.

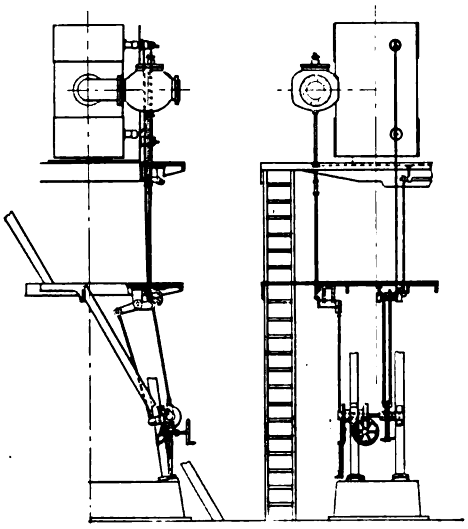


FIG. 7.—THROTTLE VALVE GEAR.

The first engines erected in the large extension of the engine room, that has recently been completed, are vertical cross-compounds of 2400 horse-power nominal capacity each at 100 r.p.m. and 160 lbs. gauge pressure. These are also McIntosh & Seymour machines. The speed is guaranteed to be maintained constant within 2 per cent from no load to full load, and the engines are guaranteed to operate on a maximum steam consumption of 12¾ lbs. per horse-power per hour, including steam condensed in jackets and receiver. Between the two cylinders is located a reheater having a total heating surface of 800 sq. ft. The clearance is 2¾ per cent in the high-pressure cylinder and 4 per cent in the low-pressure cylinder. The throttle valve is of the quick-opening piston type, operated by a set of levers. Each engine is provided with a turning gear operated by a 5-h.p. 220-volt General Electric motor, attached to the rear of the engine bed plate and supplied with a controller and rheostat giving five running speeds; the minimum being 200 and the maximum 960 r.p.m. The valves, governors and other details of these engines are similar to those of the 1200-h.p. engines previously described.

With the advent of these two latest engines an important change in the methods of condensation was introduced, and this change extends also to the seven engines previously installed. Instead of providing a separate pump and condenser for each of these new engines, both exhaust

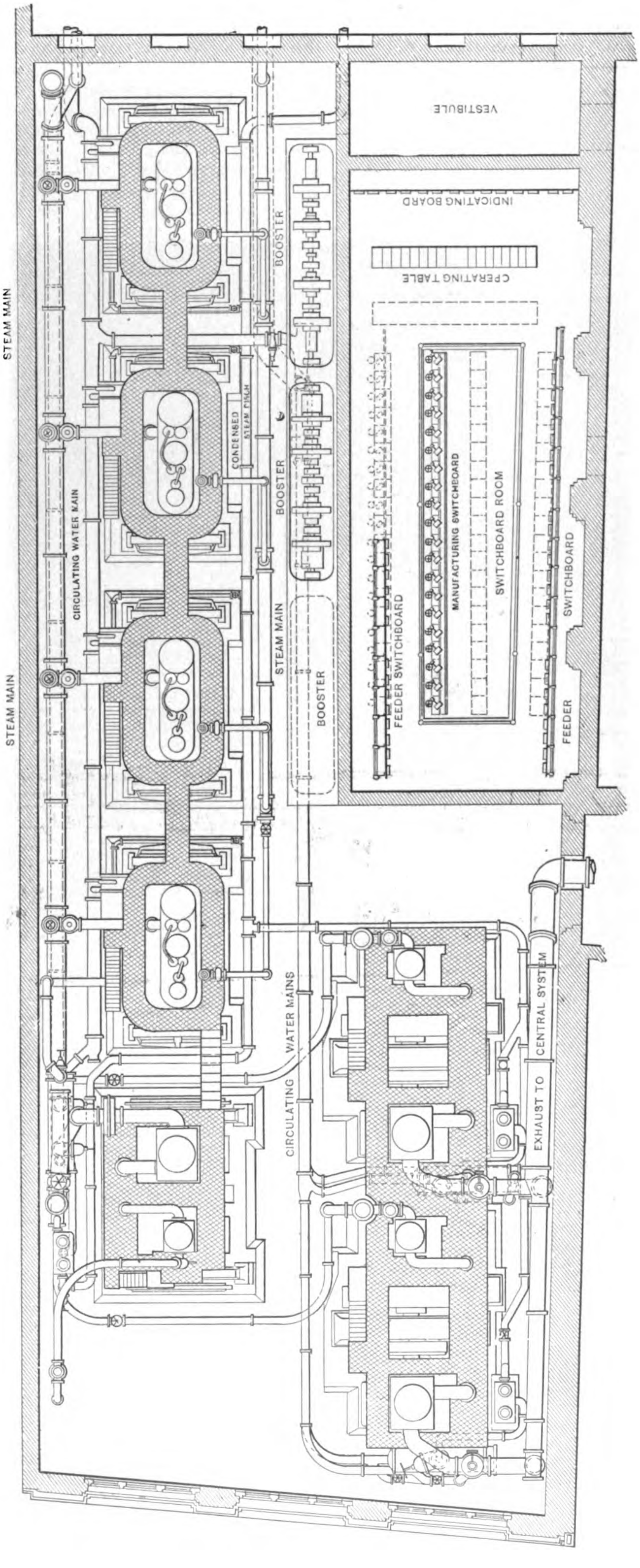


FIG. 8.—PLAN VIEW OF THE OLD ENGINE ROOM; ATLANTIC AVENUE STATION.

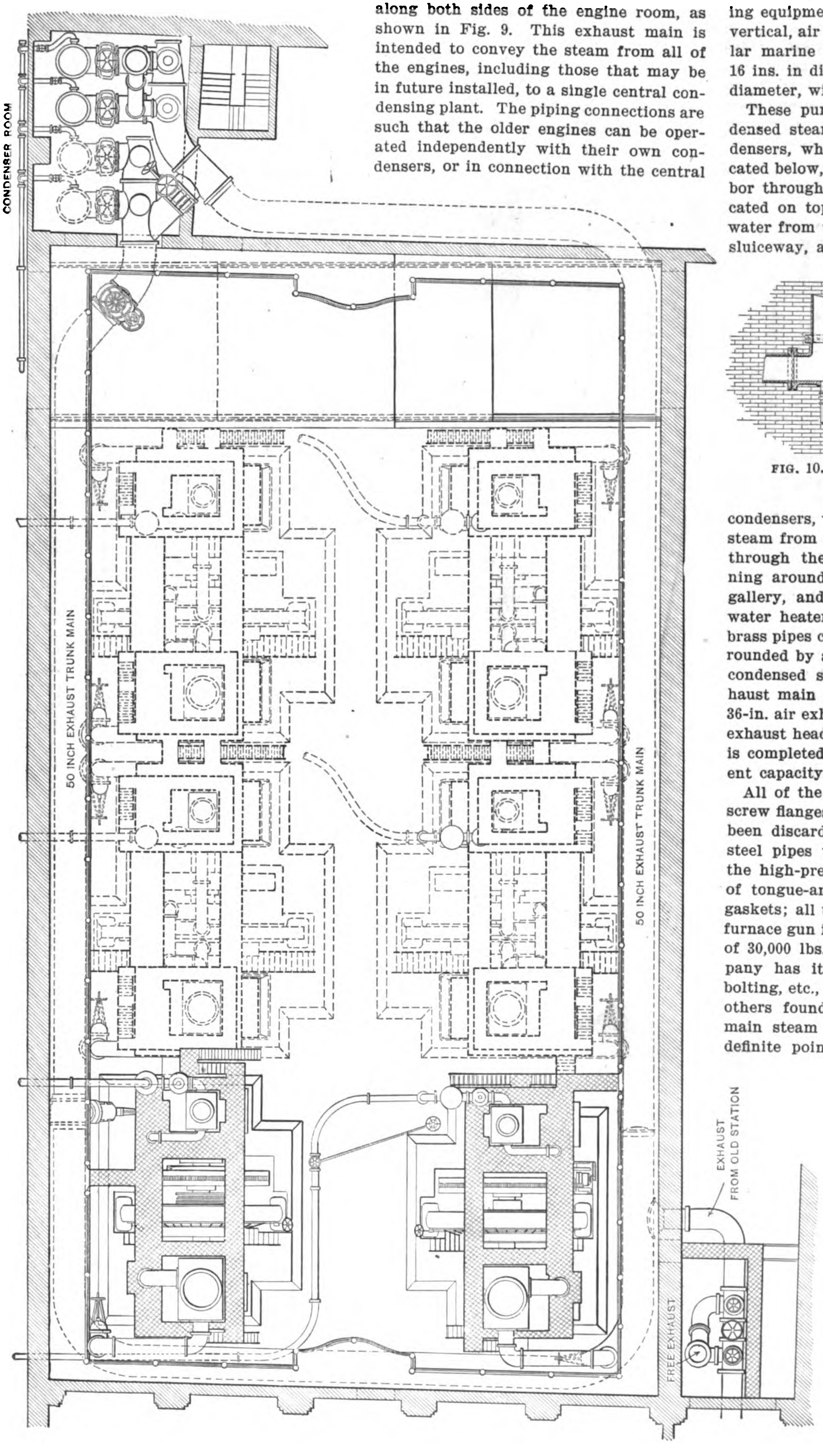


FIG. 9.—PLAN VIEW OF THE NEW ENGINE ROOM AND THE CONDENSER ROOM.

into a 50-in. exhaust main that extends along both sides of the engine room, as shown in Fig. 9. This exhaust main is intended to convey the steam from all of the engines, including those that may be in future installed, to a single central condensing plant. The piping connections are such that the older engines can be operated independently with their own condensers, or in connection with the central condensing system. The central condensing equipment comprises two Blake, twin, vertical, air pumps (inverted) of the regular marine type, having steam cylinders 16 ins. in diameter and buckets 44 ins. in diameter, with a common stroke of 24 ins.

These pumps take the water and condensed steam from the Knowles jet condensers, which are of the cone type, located below, and discharge it into the harbor through the 48-in. discharge pipe located on top of the sluiceway. The salt water from the channel flows through the sluiceway, already described, into the jet condensers, where it is met by the exhaust steam from the engines which has passed through the 50-in. condenser pipe, running around the engine room under the gallery, and also through Goubert feed-water heaters, consisting of a number of brass pipes conducting the feed water, surrounded by a chamber through which the condensed steam passes. The 50-in. exhaust main is furnished with two 30 and 36-in. air exhaust pipes, having Sturtevant exhaust heads. When the condenser room is completed it will have double its present capacity.

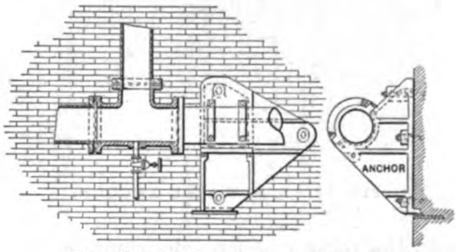


FIG. 10.—STEAM PIPE ANCHOR

All of the copper pipe and most of the screw flanges, as originally installed, have been discarded and are now replaced by steel pipes with flanges welded on. All the high-pressure steam pipe is made up of tongue-and-groove joints with copper gaskets; all the fittings being made of air-furnace gun iron, having a tensile strength of 30,000 lbs. per square inch. The company has its own standard for flanges, bolting, etc., those used being heavier than others found in common practice. The main steam pipe is anchored at certain definite points, so as to control the direction of expansion. Figs. 10 and 11 illustrate the methods of anchoring.

From the steam outlets on the boilers 6-in. vertical loops, carried high above the boilers in order to give the desired flexibility, connect to the steam mains which vary from 8 to 12 ins. in diameter. These mains run crosswise of the boiler room, discharging into short 12-in. headers parallel with and supported on the side wall between the boiler and engine rooms. From these headers, which are connected by means of 8-in. equalizing loops, the pipes lead directly to the engines.

The engines in the old room are divided into two groups, each group being supplied from a 12-in. main; the four triple-expansion engines are fed from one main and the three 1200-h.p. compound engines from the other. In the new engine room each engine has its own pipe connecting to one of the headers. Each has, besides its quick-acting throttle, an outside gate valve geared to a floor stand convenient to the engineer standing at the throttle. Each boiler is provided with an automatic stop check to prevent the back flow of steam in case of a drop in pressure or a rupture in the boiler. Each boiler has a stop valve which is geared to a handwheel located on the outside of the boiler-room wall, where it can be operated in case of an accident in the boiler room.

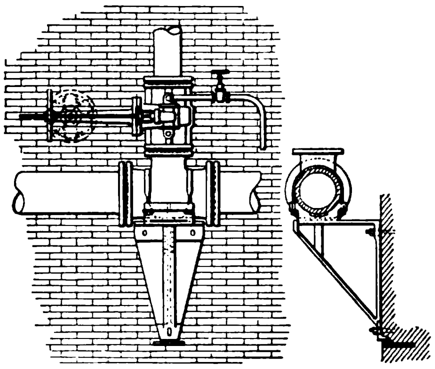


FIG. 11.—STEAM PIPE ANCHOR.

All the auxiliary apparatus, like feed pumps, circulating and air pumps, are fed independently from the boilers by means of a 6-in. pipe. All the high-pressure drains from the engines and main steam pipes are returned to the boilers by the Holly system.

The first eight dynamos installed at the Atlantic Avenue station were 200-kw. 14-pole machines, direct-connected in pairs on opposite ends of their engine shafts. The armatures of these dynamos are of the Gramme type, each having a winding of 980 convolutions formed by U-shaped copper bars and commutator bars that unite the ends of the U-shaped bars. The two dynamos mounted on each engine shaft operate on the two sides of a three-wire system, one between the positive and neutral and the other between the negative and neutral wires. These four dynamos are plain shunt-wound machines. The two dynamos next added are of 400 kilowatts capacity each, and are mounted on opposite ends of the shaft of the first 1200-h.p. engine described above. These two dynamos are similar to the first eight, and are also connected on opposite sides of the three-wire system. The two dynamos next added, which are driven individually by the sixth and seventh engines, are of 800 kilowatts capacity each.

The generator is located between the high-pressure and low-pressure cranks. The speed is 100 r.p.m. and each machine is guaranteed to deliver 2666 amperes at 300 volts, or 2963 amperes at 270 volts.

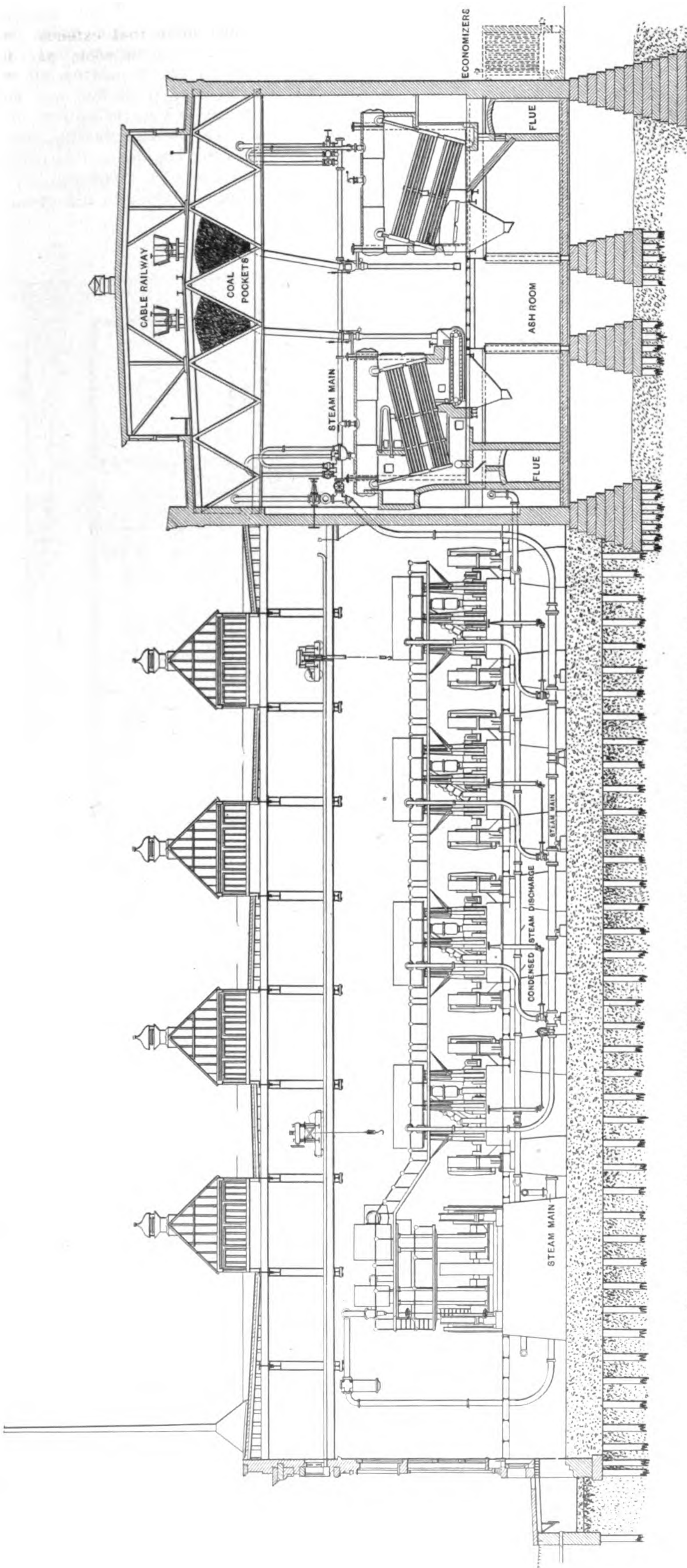


FIG. 12.—SECTIONAL ELEVATION LONGITUDINALLY THROUGH THE OLD ENGINE ROOM AND CROSS-WISE OF THE OLD BOILER ROOM.

These machines furnish current to the outside wires of the three-wire system. The frame consists of a circular cast-iron yoke with 16 inwardly projecting poles of cast steel. The armature is of the ironclad or slotted core type, ventilated by means of air ducts. The armature winding consists of copper bars, laid in slots and insulated from the armature core by means of alternate layers of oiled linen and paper. The outside diameter of the armature is 10 ft.

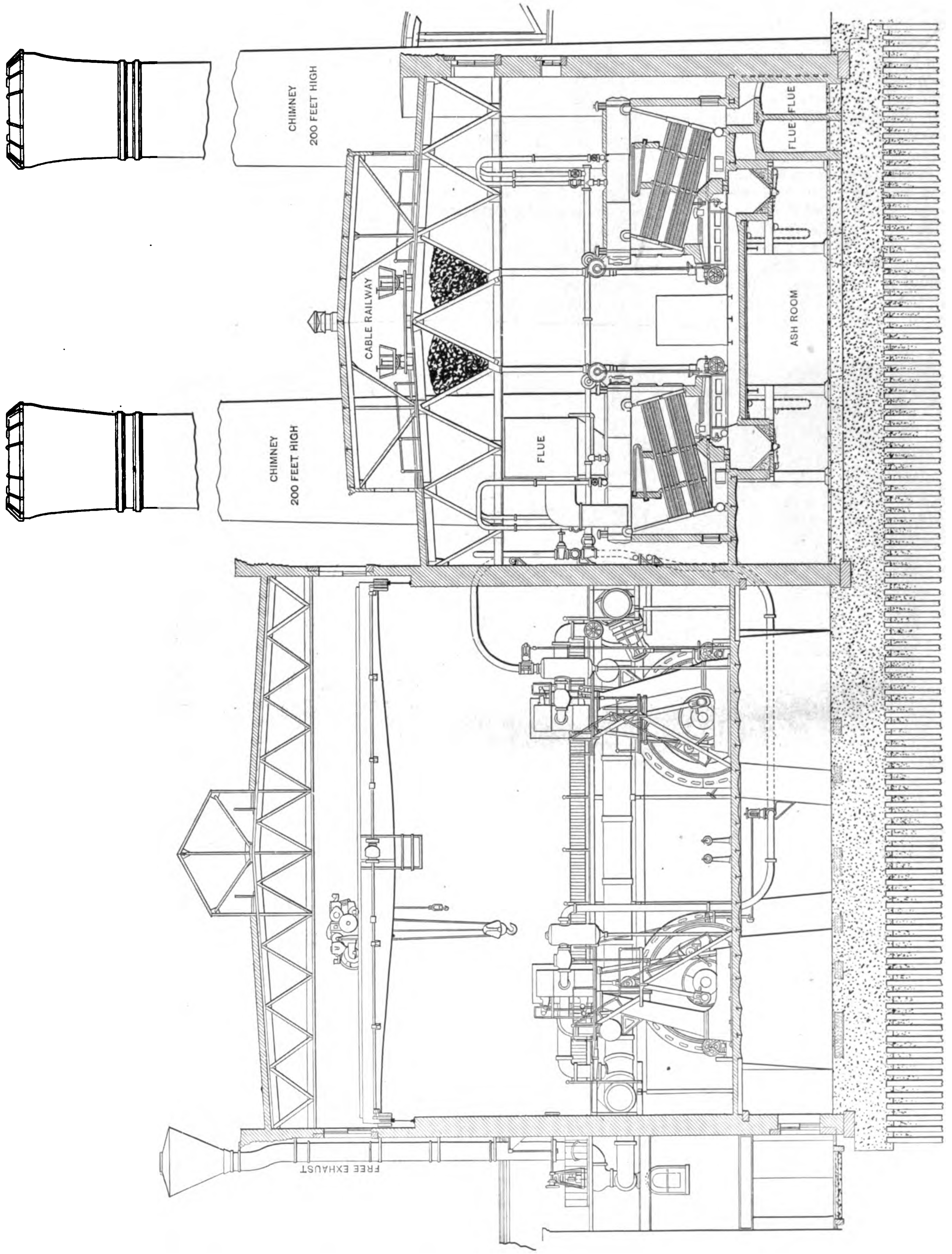


FIG. 18.—SECTIONAL ELEVATION THROUGH NEW ENGINE ROOM AND BOILER ROOM.

The two generators last installed, which are driven by the 2400-h.p. engines in the new engine room, are rated at 1600 kilowatts each, and designed for 300 volts. These dynamos are of standard modern design, like the two last mentioned. One of them has 22 poles and the other 30. This latter generator is also provided with six collector rings, making it a double-current machine. Its rated capacity is 5330 amperes at 300 volts, direct current, or 2500 amperes on each of the six phases at 184 volts, alternating current, or a proportional amount of either if both kinds of current are taken from the machine at the same time. As it has 30 poles and runs at 100 r.p.m., the frequency is 25 cycles per second. A double-current generator was adopted in this last case in order to cut down the cost of conductors to some distant parts of the system, which will ultimately be supplied with alternating current through step-up transformers at the station.

The engine room is equipped with a 50-ton overhead traveling crane, running the length of the room on tracks and built by the Morgan Engineering Company, of Alliance, Ohio. This crane is one of the largest in existence, having a span of 80 ft. 10 ins. It is provided with two hoists; a main hoist having a capacity of 50 tons, with a maximum lift of 56 ft. and an auxiliary hoist of 5 tons capacity and a lift of 62 ft. The main hoist has a speed of 11 ft. a minute at full load, the speed increasing with decrease of load. The auxiliary hoist has a speed of 50 ft. a minute. The cross travel varies from 80 ft. to 100 ft. a minute, and the longitudinal travel from 100 ft. to 150 ft. a minute. The armature of the hoisting motor is provided with an automatic electric brake, released by solenoids and applied by gravity, so that if the current should fail from any cause the brake would immediately apply itself and prevent the running down of the load. The main hoist is also supplied with a mechanical brake. The crane is operated by four 220-volt General Electric enclosed multipolar electric motors of different capacities, as follows: Main hoisting motor, 50 horse-power; auxiliary hoisting motor, 25 horse-power; trolley travel, 5 horse-power; and the bridge travel, 30 horse-power. The motors are all controlled from a cage suspended from the crane, in which are installed four Morgan lever controllers, and reversing switches. This crane can pick up the heaviest piece which comes into the station from a dray in the driveway, lifting it through the sliding door opening and depositing it in its required position without its being removed from the hoisting hook.

In the southeast corner of the old engine room, as has been stated before, there is partitioned off a switchboard room, containing a feeder switchboard gallery, a regulating room and a motor operated switchboard. On the north side of the gallery is located a feeder switchboard, made of Tennessee marble, equipped with 5-way switches, connecting the feeders to any one of five different bus-bars on each side of the system. These five sets of bus-bars are maintained at different potentials by means of motor-driven boosters connected between successive bars. There are two three-wire booster sets, each capable of an output of 1350 amperes at 55 volts. The booster switches are located on the same board with the five-way feeder switches mentioned above. Above the switches are ammeters, of both the Weston and Thomson astatic types, in series with the feeders. Located at the end of this feeder board are four dial posts of the Cory system of engine telegraph, there being one for each engine room. Each set consists of one disc, signifying the engine or booster in question, the other denoting the instructions to be given regarding that unit.

On the opposite side of the room is another feeder switchboard similarly equipped and containing also the battery switches. At the east end of the switchboard is the regulating platform, containing a board carrying all the main dynamo ammeters, also the control wheels of the field rheostats. A pressure wheel, having blocks connected to the pressure wires of all of the feeders, is so arranged that by moving the wheel around to a certain pressure block, the

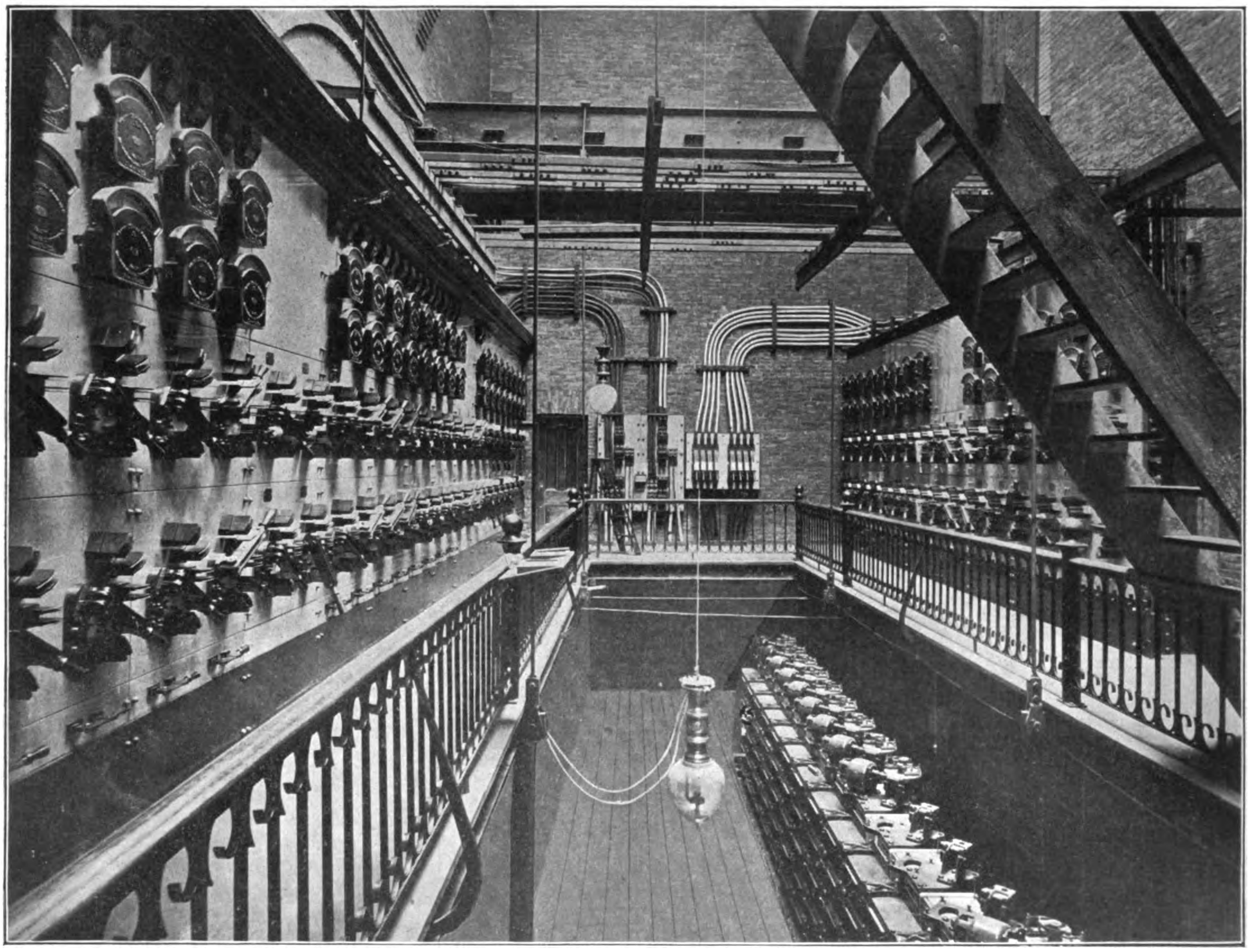


FIG. 14.—VIEW IN THE SWITCHBOARD ROOM OF THE ATLANTIC AVENUE STATION.

voltage on that feeder can be determined. An ammeter connected in series with the station neutral wire shows how much the system is out of balance and which way. There are also installed here the battery neutral meters, Weston galvanometers for switching in the machines and other miscellaneous instruments.

Extending across the regulating platform are located the operating tables, upon which are located the control wheels for the dynamo fields, also the apparatus for controlling General Electric motor switches located on the floor below. Each switch is made up as follows: A copper post extends vertically along the length of the switch, through the floor, and is connected to the source of the current. Behind each row of switches are five bus-bars, to which are attached, one for each switch, five blocks of copper having their faces in line with the face of the copper post. There are, mounted on a supporting pillar having a slate base, five copper pressure contact switches, which make connection between the copper post and the copper block on one of the bus-bars. The contact switch is made up of strips of copper, bent into the form of a hollow D, the ends making contact. These are each provided with an auxiliary circuit breaker and a magnetic blow-out. The whole switch is operated by a General Electric 2¼-h.p., 115-volt motor, so arranged that by pressing a certain button at the operating table, the corresponding switch will be closed or opened as desired.

If one switch is operated while another on the same post is making contact, the latter switch will open automatically before the former one closes, so that no two switches on the same post can make contact with two bus-bars at the same time. There are 40 of these sets of switches, located 20 in a row along the length of the switchboard room, the positive switches thus being separated from the negatives. Each set of switches is enclosed in a neat box-like casing, made of pink Tennessee marble, the magnetic blow-out driving the arc away from the switch toward the marble partition.

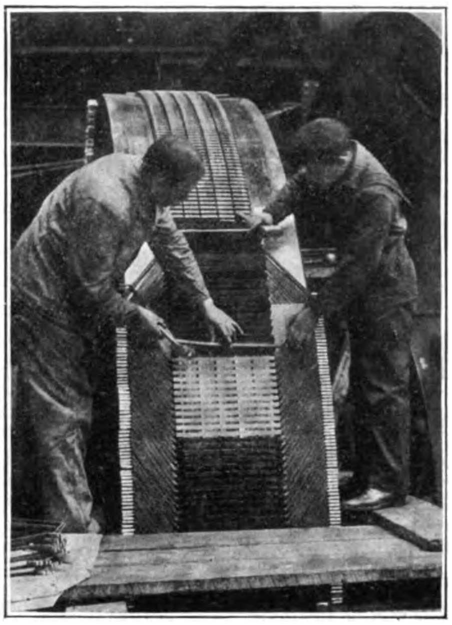


FIG 15.—PUTTING ON THE ARMATURE CONDUCTORS OF THE 800-KW. MACHINE.

As intimated in the first part of this article, storage batteries are employed for purposes of regulation and to take care of load peaks. At the First District station there are two sets of batteries, 144 Tudor cells having a capacity of 4890 amperes when discharged in three hours, and 150 chloride cells having a capacity of 2800 amperes for three hours. At the Second District station there is a battery of 140 chloride cells, and at the Atlantic Avenue station just described there are two batteries, each comprising 150 chloride cells. The three-hour discharge rate here is 5600 amperes. The regulating switches are installed in a small regulating room on the first floor, partitioned off from the battery room, and consist of 12 switches, three in multiple, on each side of each battery. These switches are operated by electric motors through a set of gears and are controlled in the regulating room of the station at a distance of 200 ft. by means of push buttons on the switchboard. The main current to and from the batteries flows along underground cables connected to the battery bus-bars on the third-station switchboard.

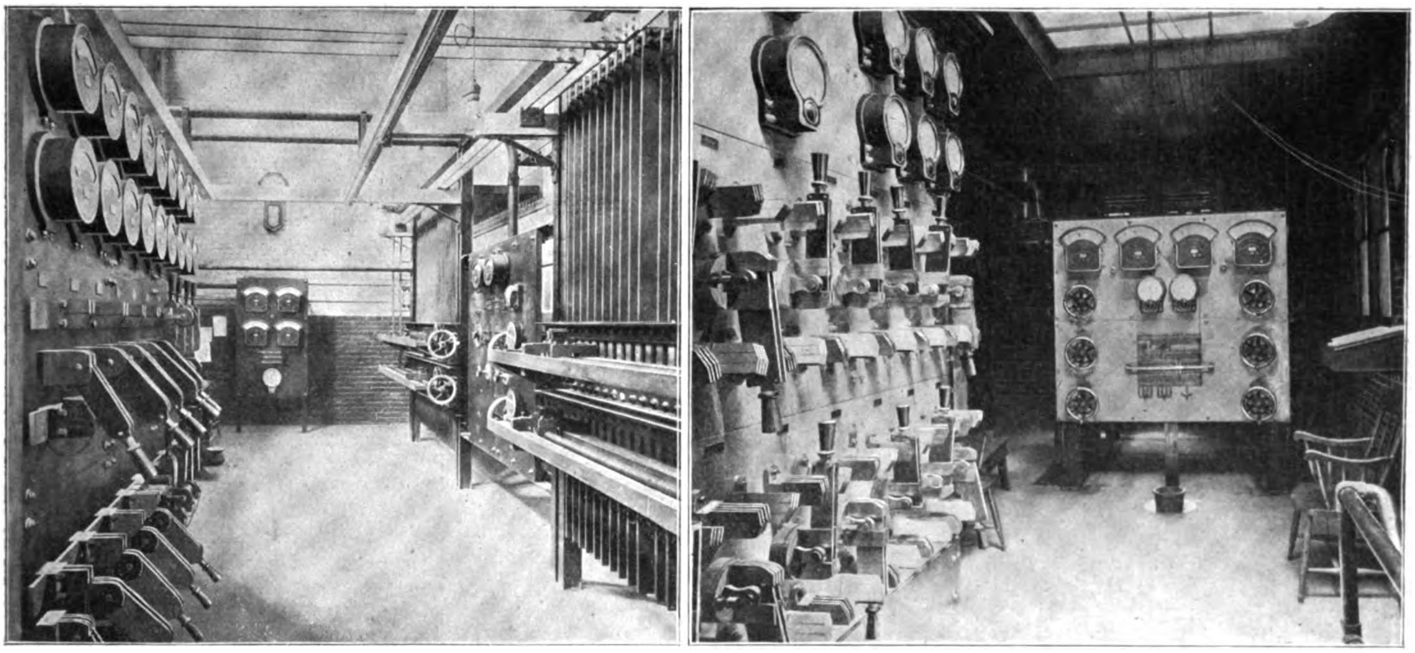


FIG. 16.—SWITCHBOARD ROOMS AT THE FOURTH AND FIFTH DISTRICT SUB-STATIONS.—FIG. 17.

The Fourth District station supplies the district known as the Back Bay, and was not only the first exclusive battery plant erected by the company, but the first one in existence. It contains a chloride battery of 144 cells. The copper bars from the end cells pass through the partition to the regulating room, where they are connected to three switches in multiple, on both sides of the system, so that the batteries can be discharged at three pressures at the same time. These switches are operated by hand. Between the two regulating switches is a slate-regulating board upon which are mounted Weston portable voltmeters, reading to three volts, so arranged as to read, through circular cell switches, the voltages of the regulating cells on each side of the system. There are also on this board two Weston round pattern galvanometers and two booster field regulators. Opposite the regulating switches is the feeder switchboard which has two busses on each side of the system, and to the apparatus and feeders are connected two double-throw switches, thus permitting of the connection of any of them to either bus. Weston round-pattern ammeters are used to indicate the load carried by each feeder. There is also installed at this station one three-wire booster set, consisting of four 60-kw. Edison bipolar dynamos, the booster armatures having been rewound. Fig. 16 is a view in the switchboard room of this station.

The Fifth and Sixth District stations, like the Fourth District, are battery stations only. At the Fifth District there are 144 Tudor cells having a three-hour discharge rate of 2570 amperes. There is also a three-wire booster set here like the one at the Fourth District station. The Sixth District station is the most recent one. It contains 140 chloride cells having a three-hour discharge rate of 1520 amperes.

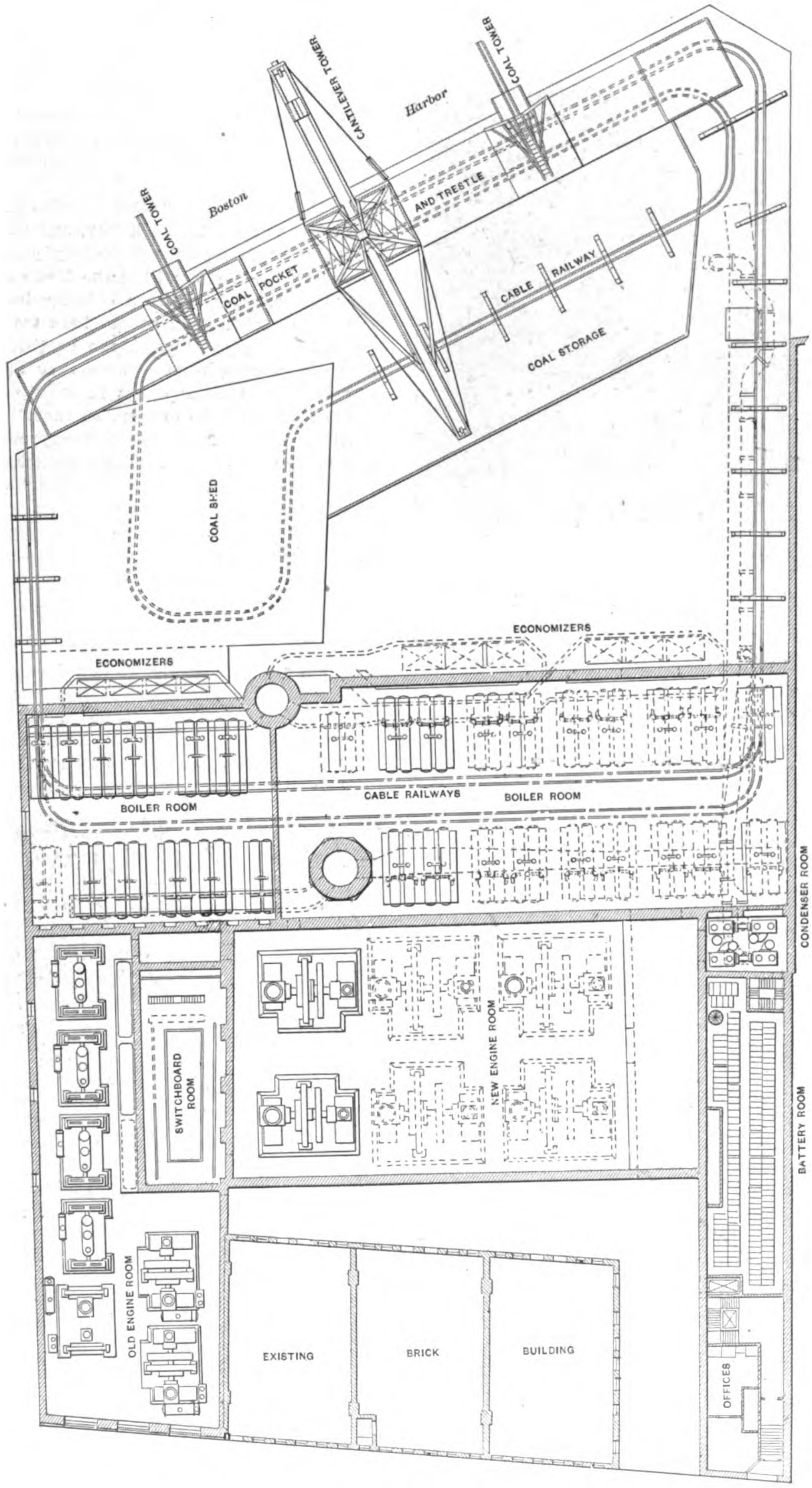


FIG. 18.—GENERAL PLAN OF THE ATLANTIC AVENUE STATION

The regulating apparatus and booster set are similar to those in operation at the Fourth and Fifth District stations, which have just been briefly described.

THE ARC LIGHTING PLANT OF THE HOBOKEN DIVISION, UNITED ELECTRIC CO. OF N. J.

The central-station plant at Hoboken, N. J., furnishes an excellent example of the general saving obtainable from the conversion of a plant containing engines and generators of all sorts into a modern systematic equipment in which the various units are reduced to the lowest number compatible with reliability of operation. Before it was remodeled, the Hoboken station was a "horrible example" of the mixed type, in which alternators and direct-current dynamos of promiscuous sizes, types and classes were jumbled together—a representative of the large class of plants which were increased in output by the addition of first one sort of equipment, then another, until the absolute limit of practical operation was anticipated by the reorganization of the generating machinery.

As the arc-lighting plant, which forms the subject of this article, is dependent for its motive power upon the generating plant which supplies current for the incandescent service, a brief reference to the latter division of the plant will be necessary in order to make the description complete.

The boiler equipment for the entire plant consists of five Babcock & Wilcox water-tube boilers rated at 520 horsepower each, and equipped with Roney mechanical stokers, the mechanism of which is driven by two Westinghouse vertical engines. At present, coal is delivered to the stokers by shovel, but preparations are being made for the installation of a coal-handling equipment that will take the coal from the bins and deliver it directly to the hoppers of the stokers. A Green economizer has been installed in the boiler room and the mechanism of this outfit is driven by a 7-h.p. General Electric motor and a 5-h.p. steam engine. Induced draft for the furnaces is used. The draft fans are of the Buffalo Forge Company's make, 14 ft. in diameter, and are driven by horizontal engines having cylinders 12 ins. x 16 ins. and running at 75 r.p.m. Feed water for the boilers is taken from the city mains and delivered by Worthington tandem compound duplex pumps, having cylinders 8 ins. and 7 ins. in diameter, respectively, and 12 ins. stroke. The steam piping from the boilers to the engines is carried under the engine room floor, which occupies a level about 8 ft. above the level of the boiler room floor. Steam is delivered to the engines at 140 lbs. pressure.

The steam engine equipment now consists of one cross-compound condensing engine, built by the Pennsylvania Iron Works Company, Philadelphia, Pa., and two cross-compound condensing engines, built by the Providence Engineering Works, of Providence, R. I., each engine being direct-connected to an S. K. C. 750-kw. inductor alternator, built by the Stanley Electric Manufacturing Company, Pittsfield, Mass. Each engine has cylinders 26 and 48 ins. in diameter, respectively, by 48 ins. stroke, all of the engines being of the same size and of the Corliss type. Fig. 2 gives a general view of the generating units, and Fig. 5 shows one of the alternators at close range. The alternators are two-phase machines, delivering current at 2600 volts and 60 cycles.

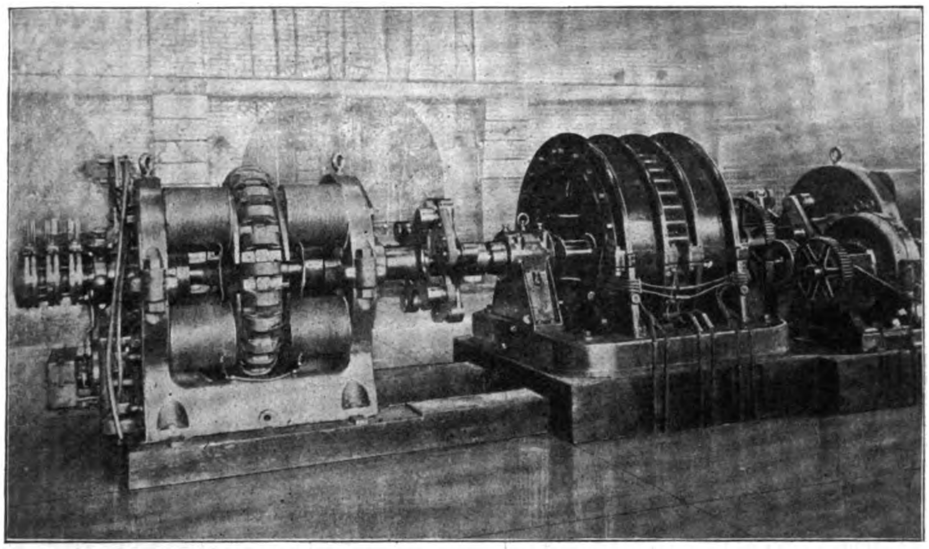


FIG. 1.—SYNCHRONOUS MOTOR AND ONE OF THE ARC DYNAMOS.

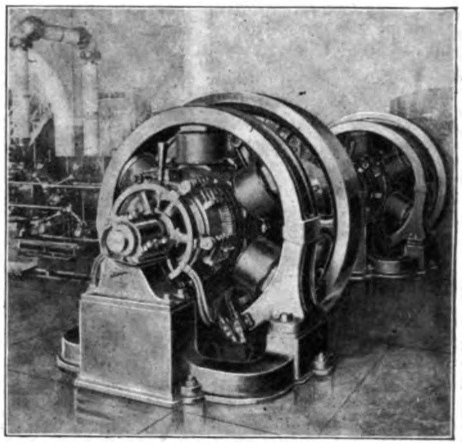


FIG. 3.—THE EXCITER DYNAMOS.

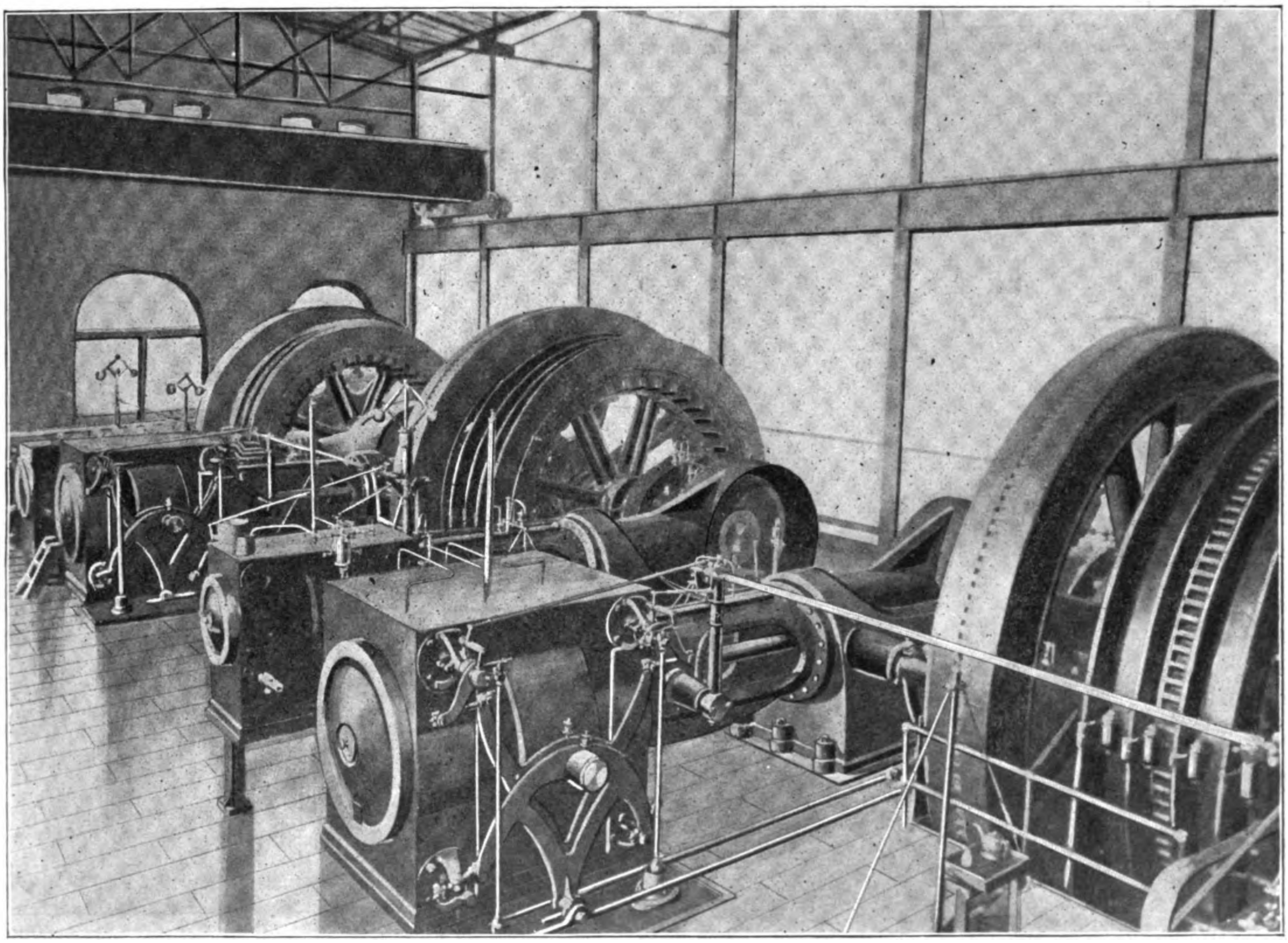


FIG. 2.—GENERAL VIEW OF THE MAIN GENERATING EQUIPMENT.

As previously stated, this current is used for both the arc-lighting and incandescent-lighting services, but it is not supplied directly to the arc-lighting circuits; these circuits are operated by direct constant current supplied from modern Brush arc-light dynamos, which are driven by S. K. C. two-phase synchronous motors. There are four of the synchronous motors, each of 150 kilowatts capacity; each motor is direct-connected to two 125-light dynamos, which it drives through the medium of link couplings, as indicated in Fig. 1. As the illustration plainly shows, these couplings consist of a four-arm spider mounted rigidly on the end of the dynamo shaft and connected by means of leather links to a similar spider on the end of the motor shaft. The synchronous motor is brought up to running speed by means of a 15-h.p. direct-current motor of the Sprague Electric Company's make. Three of these starting motors are supplied with current from the street-railway system, the generators of which are located in the same building. The starting motor is geared to the synchronous motor shaft through an intermediate raw-hide pinion, which is mounted on the end of a lever and adapted to be thrown out of mesh when the motor has been brought up to speed. The arrangement is such that in throwing the intermediate pinion out of mesh the arm on which it is pivoted is moved in the direction in which the pinion would be thrust by the action of the gear on each side of it if it were left floating free. It is put into mesh, of course, while the machines are stationary, so that there is no tendency whatever to strip the teeth.

The synchronous motor fields are excited from the same machines which supply the field current to the alternators. These are two 60-kw. 125-volt General Electric dynamos of the ordinary multipolar type, as illustrated in Fig. 3. The

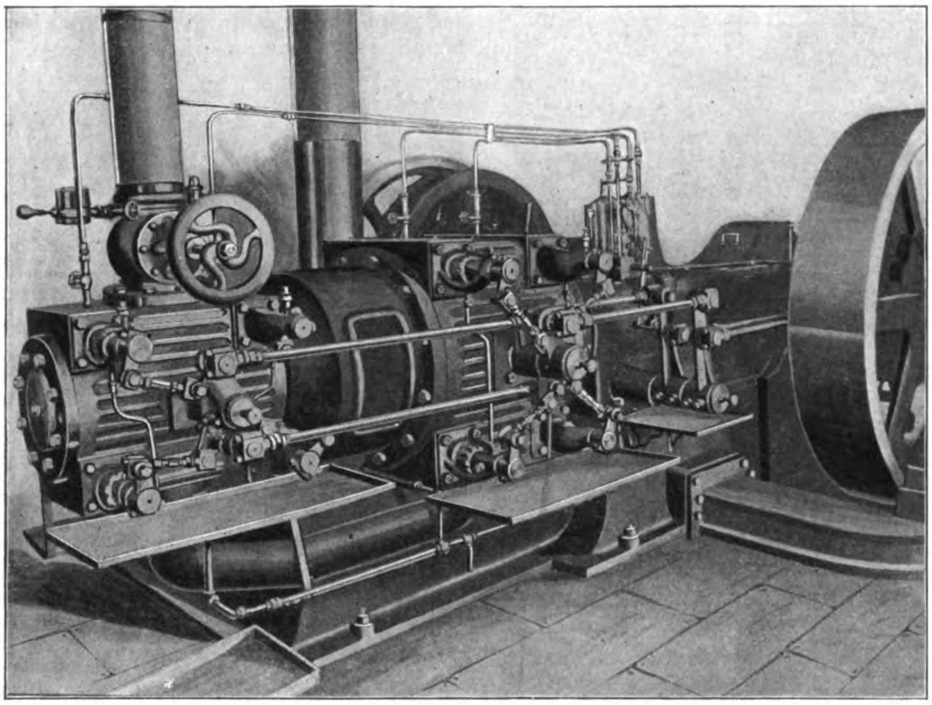


FIG. 4.—TANDEM-COMPOUND ENGINE DRIVING EXCITER DYNAMO.

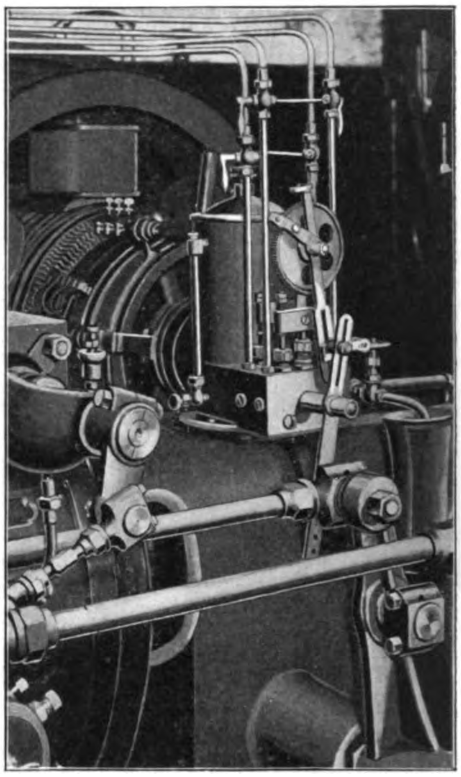


FIG. 6—THE AUTOMATIC OILING MECHANISM.

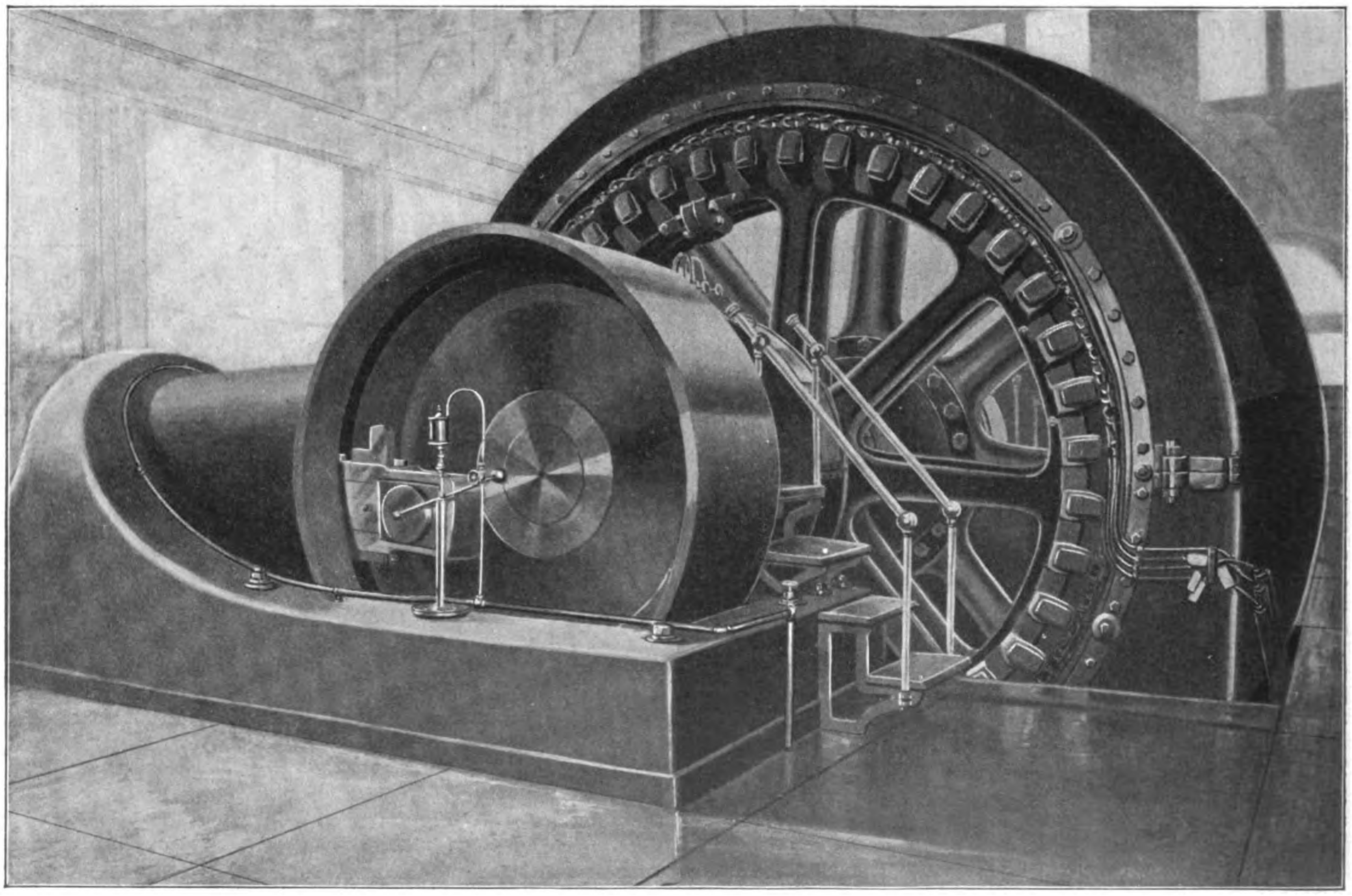


FIG. 5.—TWO-PHASE 750-KW. ALTERNATOR DIRECT-CONNECTED TO CROSS-COMPOUND CORLISS ENGINE.

two exciter dynamos are direct-connected to tandem-compound four-valve engines of 100 horse-power each, built by the Harrisburg Foundry & Machine Works, Harrisburg, Pa. The valve gear of one of these engines is of the modified Corliss type, and is shown very clearly by Fig. 4. On the side of each cylinder are mounted two rocker arms, pivoted concentrically, which take the place of the wrist-plate of the Corliss engines; each of these is oscillated by an individual eccentric. One rocker arm operates the admission valves and its eccentric is under the control of a shaft governor of the usual type. The other rocker-arm, operating the exhaust valves, is oscillated by the other eccentric, which, of course, is fixed on the shaft, as usual.

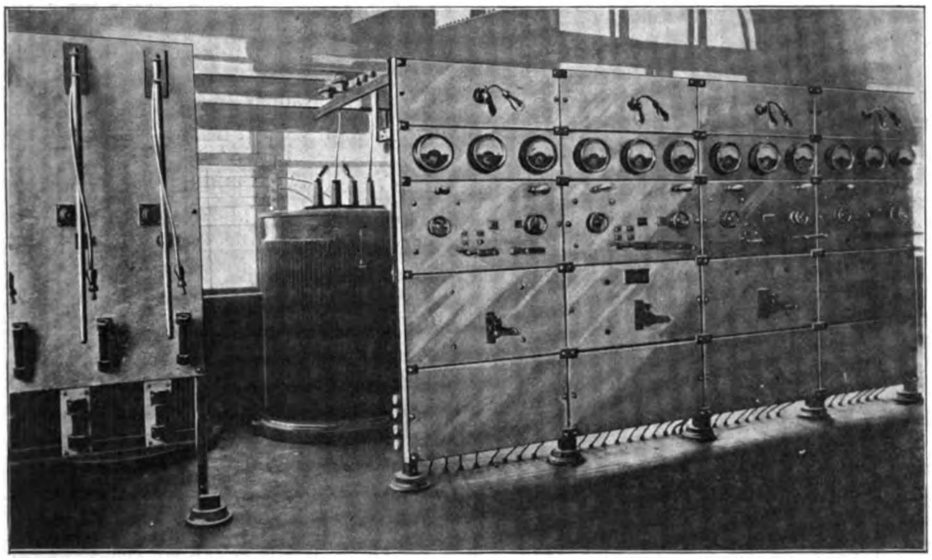


FIG. 7.—SWITCHBOARDS FOR THE CONTROL OF THE SYNCHRONOUS MOTORS.

An interesting attachment on these engines is the automatic lubricating device, illustrated by Fig. 6. This is a quadruple-feed improved lubricator, manufactured by Greene, Tweed & Co., New York, and consists of a reservoir tank, similar to that of an ordinary sight-feed lubricator, from which oil is delivered to the four feed pipes by means of small pumps which receive their motion from a link connected to the valve gear of the engine. The action of this lubricator is entirely automatic, the supply of oil being adjusted in accordance with the needs of the engine, and as the oil is pumped under pressure to the points where it is used, the supply is positive and reliable. Each of the four feeds is independent of the other three and can be independently adjusted.

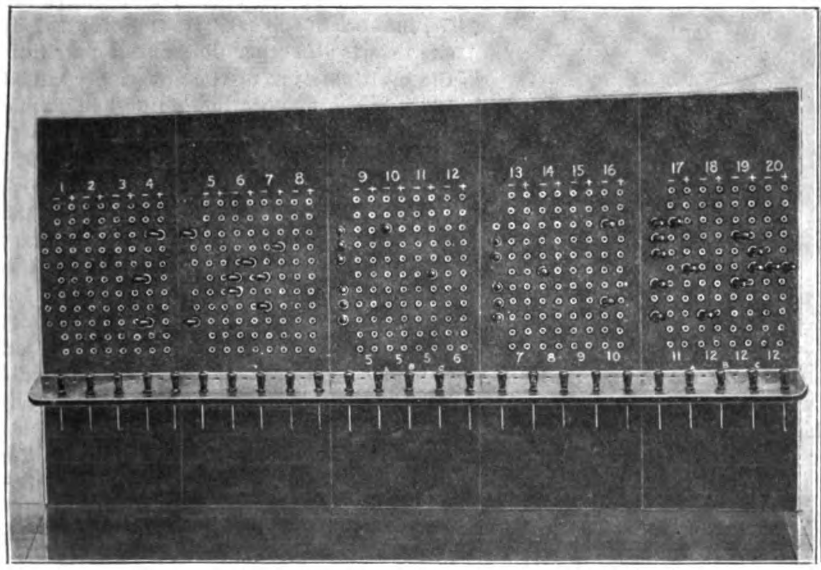


FIG 8 – THE ARC-CIRCUIT SWITCHBOARD.

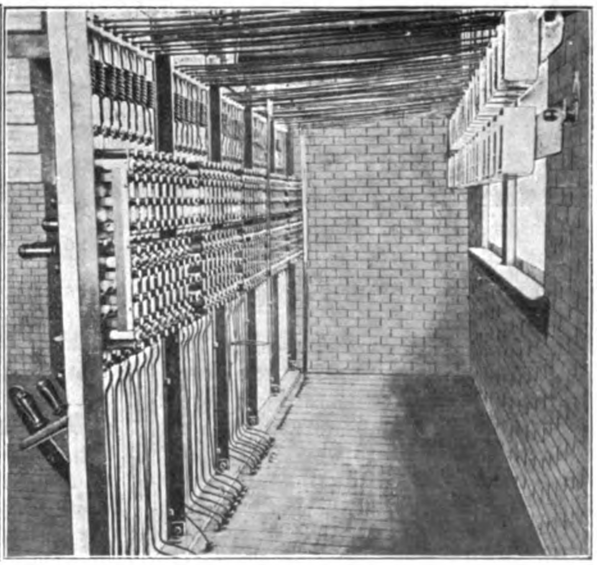


FIG. 9.—BEHIND THE ARC-CIRCUIT SWITCHBOARD.

The synchronous motors take current at the generator e.m.f. of 2600 volts through a special power panel in the main switchboard and the panel equipped with broom-handle switches shown at the left of Fig. 7. The panels from which the field circuits and starting motors are controlled are shown at the right of Fig. 7. There are four panels, one for each synchronous motor, and each panel is equipped with the usual indicating instruments, field switch and rheostat for the synchronous motors, and starting rheostat for the starting motors.

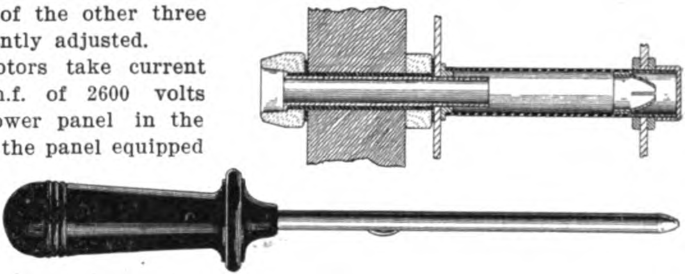


FIG. 10.—ONE OF THE PLUGS AND SOCKETS.

The arc-light dynamos deliver current to their circuits through a plug switchboard, as usual, the particular board in this plant being illustrated by Fig. 8. The board is equipped with an ammeter jack in each machine circuit, so that an ammeter placed at the top can be put in series with any one of the eight arc dynamos. One of the switchboard plugs and sockets is shown in Fig. 10. The socket is made of hard fiber and contains a solid metal sleeve at one end and a split metal sleeve at the other. The tip of the plug enters the split sleeve and the shank of the plug is pressed into intimate contact with one side of the solid sleeve by means of a spring mounted in a slot in the shank of the plug, from which it protrudes in exactly the same manner as the spring of an umbrella staff. The arc switchboard was built by the General Electric Company, and the synchronous-motor switchboard panels were built and equipped by the Stanley Electric Manufacturing Company.

The out-door arc-lamp circuits are overhead, the wires being hung on chestnut poles from 35 to 45 ft. high. The line work throughout is of a very superior character, and approaches closely to the standard established on the Orange division of this company's properties, which division is noted for the excellence of the line construction. The arc lamps are of the latest Brush type and of the Adams-Bagnall pony differential type; there are 900 lamps in all. Mr. King, the superintendent of the plant, has ingeniously converted a great many of the lamps into a sort of enclosed form by inserting an asbestos washer 1/16 in. thick between the globe and the reflector. The lamps

COMBINED EFFICIENCY OF STANLEY MOTORS AND BRUSH ARC MACHINES.

Time.	Motor No. 1 — Input in Kilo-watts.	Motor No. 1 — Output in Kilo-watts.	Motor No. 1 — Per Cent Effi-ciency.	Motor No. 2 — Input in Kilo-watts.	Motor No. 2 — Output in Kilo-watts.	Motor No. 2 — Per Cent Effi-ciency.
7:30	120.13	88.19	80.1	129.5	99.90	77.1
7:35	120.18	94.57	78.7	129.4	99.60	77.0
7:40	126.33	98.44	77.8	125.9	97.85	77.8
7:45	130.43	100.43	77.2	139.5	103.80	74.5
7:50	127.33	101.24	79.6	141.5	105.25	74.5
7:55	130.40	103.89	79.6	141.5	107.35	75.9
8:00	132.48	103.40	78.1	137.5	105.05	76.4
8:05	133.44	104.59	78.3	141.5	106.30	75.2
8:10	131.45	100.30	76.4	141.5	106.90	75.6
8:15	136.52	105.20	77.2	139.8	105.30	75.4
8:20	131.48	103.18	78.5	141.5	106.50	75.4
8:25	134.58	104.48	77.8	144.5	108.80	75.4
8:30	134.58	105.66	78.6	143.5	106.80	74.4
8:35	135.48	104.60	77.3	140.5	107.50	76.5
8:40	121.33	94.80	78.4	124.3	95.10	76.5
8:45	135.43	104.80	77.4	122.3	92.60	75.7
8:55	137.58	104.60	78.2	141.5	106.60	75.3
9:00	136.53	105.00	76.9	139.5	105.50	75.6
Average	130.58	101.60	77.89	136.9	103.77	75.85

equipped with this washer have burned over 41 hours. The upper carbons are ⅝ in. x 10 ins., cored, and the lower ones are ½ x 9 ins., solid. It is intended to equip all of the lamps with these asbestos washers.

An interesting test was recently made of the plant by Stevens Institute graduates, the results of which are given herewith. The input of the synchronous motor was measured by a wattmeter in each phase, and the output of the two arc dynamos driven by it was measured by an ammeter in each circuit, and a voltmeter which was shifted back and forth from one circuit to the other. Readings from the alternating-current circuits were also taken from time to time in order to determine the power factor of the synchronous motor. All of the instruments were carefully calibrated at the laboratory of Stevens Institute before the test was made, and the space about the instruments was explored for stray fields and found to be practically free from such interference. The power factor of each synchronous motor was found to be 0.93. The table herewith gives the results of readings taken between 7.30 and 9 P. M. on two of the arc-lighting generating sets. A test was made at the same time of the engine and alternator equipment, and the result showed a full-load efficiency of 95 per cent for the alternator.

The new station was designed by the staff of the United Electric Company of New Jersey, of which the Hoboken plant constitutes one division. The plant is conspicuously creditable to the gentlemen who were responsible for its remodeling, and among whom may be mentioned Messrs. Dudley Farrand, general manager; Paul Spencer, at the time general superintendent; H. D. King, superintendent of the Hoboken division, and E. R. Dunbar, chief engineer at the Hoboken station.

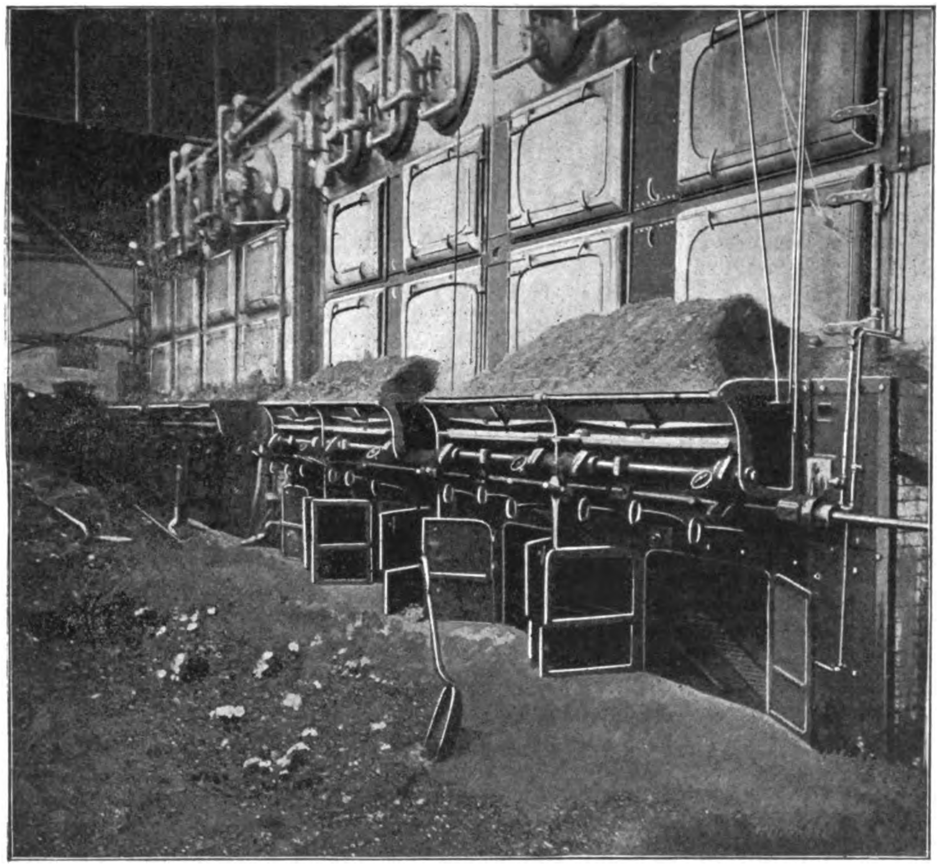


FIG. 11.—VIEW IN THE BOILER ROOM.

◆

The Longest Transmission Line in the World.—What is stated to be the longest line over which power is electrically transmitted for commercial purposes was put into operation on April 27. The transmission system referred to is that of the Bay Counties Power Company, which has lines extending from a generating station on the north fork of the Yuba River to Oakland, Calif., a distance of 140 miles. The line is operated at a potential of 40,000 volts.

THE MODERN TELEPHONE SWITCHBOARD.

BY KEMPSTER B. MILLER.

In a paper on telephone engineering which was recently read before the New York Electrical Society, Mr. Kempster B. Miller give a most interesting discussion of the fundamental features of modern telephone switchboards. The salient portions of this section of the paper are reprinted herewith:

The fundamental object of the multiple switchboard is to place within reach of every operator a line terminal or spring jack, as it is called, for every subscriber's line entering the exchange. As is well known, the switchboard is divided into sections, each section being of such size as to allow an operator, without undue exertion, to reach over its entire surface. On each section are placed a certain number of line signals, by which the subscriber is enabled to attract the attention of the operator and a corresponding number of line jacks, by means of which the operator may make the initial connection with that line in response to such signals. These jacks, which are associated with the line signals, are termed answering jacks. In addition to the line signals and answering jacks are provided what are termed multiple jacks, there being one of these on each section of every line in the exchange.

To express this in a little different way: the various lines entering the central office are divided up into suitable groups, these groups terminating in line signals and answering jacks at the various sections of the multiple switchboard. In addition to this, all the lines entering an exchange are carried to every section of an exchange, each line terminating in every section in a multiple jack. An operator seated at any section, in response to a display of one of her line signals, inserts one plug of a pair into the jack corresponding to the signal, and ascertains the number of the subscriber desired; then she inserts the other plug of the pair into the multiple jack of the subscriber called for. As every subscriber's line has a multiple jack at every section of switchboard, any operator is able to complete by herself any connection called for at her board.

The size of the section is limited by the reach of the operator, and it is this fact that places a mechanical limit to the size of an ordinary multiple switchboard. It has been found impracticable in most cases to place the jacks closer than on half-inch centers, and under these conditions no more than six thousand (6000) of the multiple jacks could be placed, in addition to the other apparatus, within the space afforded by one section. Two distinct methods have been employed with the intent of removing this limit. Each has been productive of excellent results; each has been used separately, but up to the present time they have not both been incorporated into the same installation. The first of these methods is an obvious one and contemplates the reduction in the size of the spring jacks with a view to getting more of them within the reach of the operator. The mechanical difficulties in this line have been great, owing to the fact that the circuits of the switchboard were so complicated as to require three, four, and sometimes even five contacts to each spring jack.

The second method of increasing the possible size of multiple switchboards was devised by Mr. M. G. Kellogg, and is now in use in two large exchanges in this country. In this system, which is known as the divided multiple system, the switchboard and lines are divided each into four divisions. The switchboard consists of four multiple boards, all in the same office, and to each of these is connected one of the groups of lines, in the same manner as if they were in separate exchanges. With this arrangement, if no further provisions were made, it would be possible for any subscriber in one division to obtain a connection with any other subscriber in his own division, but not with any one in any of the other three divisions. In order to enable any subscriber in, say, the *A* division to obtain a connection with a subscriber in the *B*, *C* or *D* division, means are provided, not for trunking between the divisions, but for enabling the calling subscriber to signal directly to one of the operators in the division in which the line of the called-for subscriber belongs. This necessitates the use of four line signals and four answering jacks for each line, one of each in each division, and of means whereby the subscriber may display any one of the signals to the exclusion of the others. Instead of trunking between exchanges, therefore, the subscriber sends his call directly into the division of the switchboard to which the desired subscriber belongs.

By the use of this divided multiple switchboard, it is evident, the ultimate capacity of any exchange is increased approximately fourfold; not quite this, however, because the extra line signals and answering jacks take up a portion of the room which would otherwise be available for multiple jacks.

During the past five years a complete revolution has been worked in the circuits and apparatus of telephone exchanges, due to the introduction of the system known under such names as "common battery," "central battery" and "central energy." These systems, when properly equipped, have proved vastly superior from both economic and operating standpoints to the old magneto systems, wherein local batteries were used for talking and magneto generators for making the calls. The local primary battery at the subscriber's station has been superseded by a large storage battery at the central office, which also takes the place of the old magneto generator. The mechanical signal or drop has given place to the lamp signal. By these innovations the apparatus at the subscribers' station has been rendered simpler and more compact, that at the central office more reliable, and the operation of the entire system has been rendered automatic, as far as the subscriber is concerned, and as much so as is desirable as far as the operator is concerned. Such a system employs batteries at the central office for furnishing all current, for signaling by the subscriber and for the operation of the talking apparatus. These batteries are invariably secondary rather than primary, for large exchanges, and operate almost universally at the voltage given by ten cells in series, i.e., 20 to 24 volts, according to state of charge.

In the modern common battery exchange the operation is such that when a subscriber removes his receiver from the hook, a lamp will be automatically lighted in front of the central office operator who handles the calls of the group of subscribers to which this particular subscriber belongs. The operator in response to this signal makes connection with the subscriber's line by inserting a plug into the spring jack of that line, and after having ascertained his wants, completes the connection with the subscriber called for by means of a second plug connected to the first one through flexible cords. As soon as a connection is thus made with a subscriber's line, the line lamp normally in control of the subscriber is disconnected from the line, but another lamp connected with the plug is placed under the control of the subscriber, this lamp being known as a supervisory lamp.

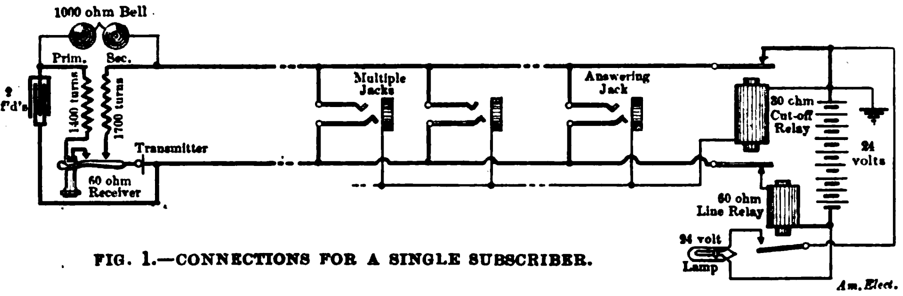


FIG. 1.—CONNECTIONS FOR A SINGLE SUBSCRIBER.

In Fig. 1 is shown a complete line circuit in diagram, including the apparatus at the subscriber's station, which is shown at the left, and the apparatus at the central office, which is shown at the right. The apparatus at the subscriber's station consists of an induction coil, a receiver, a granular carbon transmitter, a condenser of two microfarads capacity, a 1000-ohm bell and an automatic hook-switch. It will be noticed from the diagram that the circuit between the two sides of the line is held open to direct currents by the condenser, and to all currents by the hook-switch contact, while the receiver is on the hook. This leaves the bell in operative relation to the line, for the purpose of receiving calls; the path of the ringing current (which is alternating) being through one side of the line, through the bell and condenser to the other side of the line. When the receiver is removed from its hook, the circuit between the two sides of the line is closed, allowing the passage of direct current through the secondary of the induction coil and the transmitter in series. At the same time another circuit containing the transmitter, the receiver, the primary of the induction coil and the condenser is closed. The object of this latter circuit, which is local to the subscriber's station, will be pointed out later.

At the central office, in addition to the answering jack and the multiple jacks, there are two relays, one termed the line relay, which is normally in circuit across the line in series with the 24-volt storage battery common to all lines, and the other termed the cut-off relay, which is in an auxiliary circuit, and is adapted to open the circuit through the line relay and the battery as soon as a plug is inserted into any jack belonging to its line. Under normal conditions, both relays remain unoperated and the conditions are as shown. As soon, however, as the subscriber removes his receiver from its hook, the circuit between the two sides of the line is made complete at the subscriber's station and the current at the central office energizes the relay which closes the circuit containing the battery and the line lamp.

This lamp is located in immediate proximity to the answering jack, and the operator, seeing it light up, inserts a plug into the answering jack in response to the call. This plug is one of many pairs within the reach of the operator and has three contacts, two of which, the tip and sleeve, are adapted to engage the two springs of the answering jack, and thus complete the talking circuit. The third is adapted to engage the ring contact of the jack, and being in connection with the live side of the battery, causes a current to pass from this side of the battery through the ring contact of the jack and the coil of the cut-off relay back to the other side of the battery. The energization of the cut-off relay serves to open the circuit of the line relay, and thus extinguishes the lamp.

One of the cord circuits is shown in Fig. 2. In this diagram the answering and calling plugs are shown at the extreme left-hand and right-hand portions, respectively, each having, as before said, three contacts, two of which, the tip and sleeve, are connected by wires shown in heavy lines, which form part of the talking circuit, and the third of which is connected through the supervisory signaling lamp and one winding of a repeating coil to the live side of the battery, as shown. The tip and sleeve of the answering plug are connected together through the two halves of one side of a repeating coil, between which is connected the common battery. In the same manner the tip and sleeve strands of the calling plug are connected by the two halves of the other winding of the same repeating coil between which is connected the same battery.

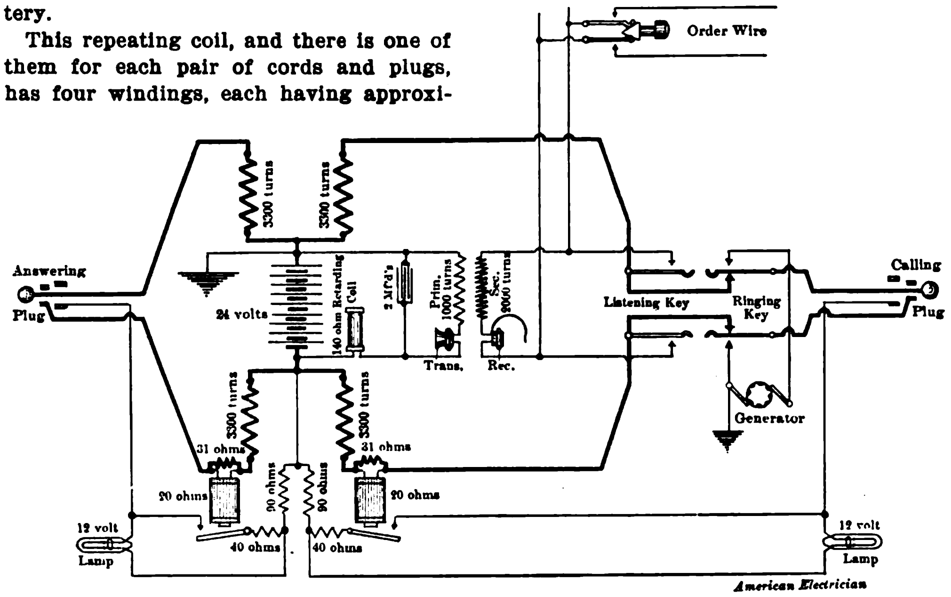


FIG. 2.—DIAGRAM OF A CORD CIRCUIT; COMMON BATTERY EXCHANGE.

This repeating coil, and there is one of them for each pair of cords and plugs, has four windings, each having approximately 3300 turns, all of these windings being on the same magnetic core. It is evident that these connections allow current from the storage battery to pass out over the metallic circuits of the two connected lines and energize the transmitters. A fluctuation in the current flowing in either line will, however, by induction between the windings of the repeating coil, cause a corresponding fluctuation in the current of the other line. In this way conversation between two connected lines is made possible, it being by induction rather than conduction.

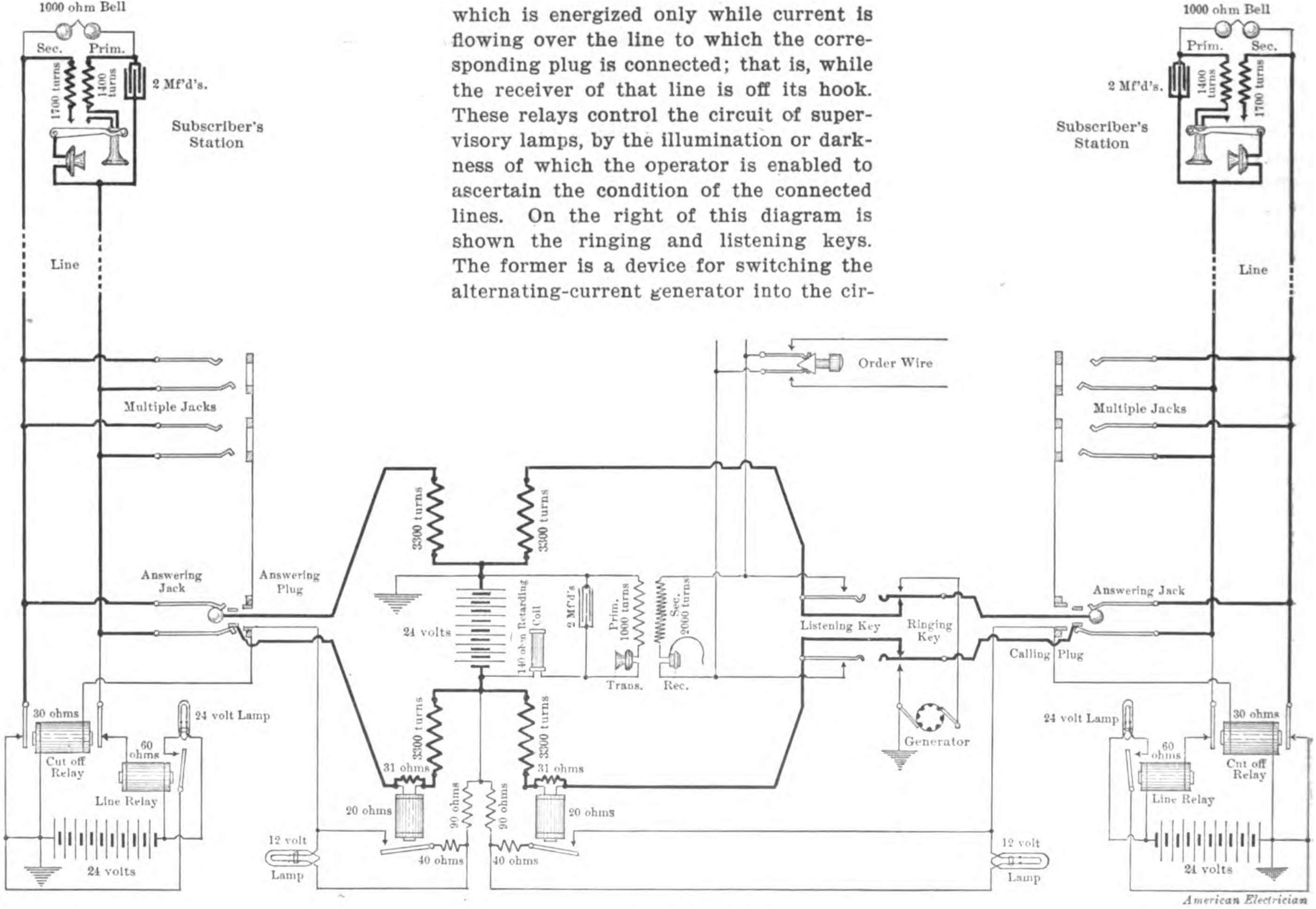
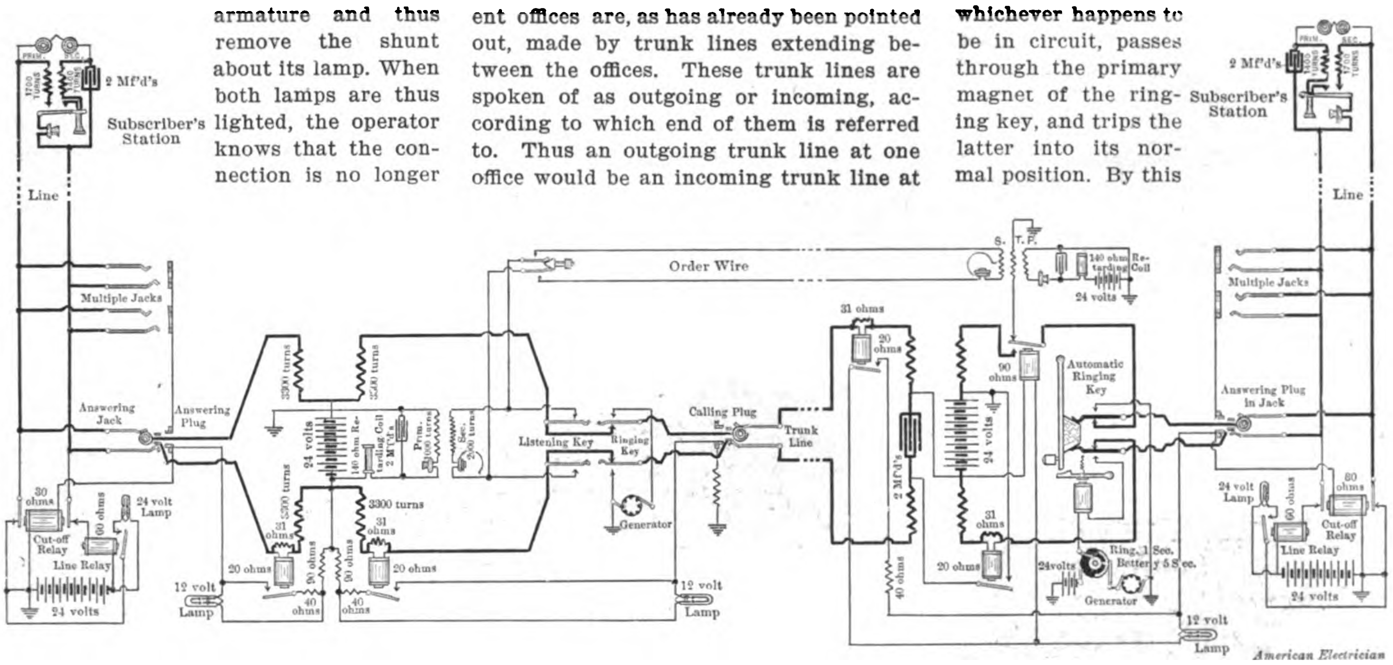


FIG 3.—DIAGRAM OF CONNECTIONS BETWEEN TWO SUBSCRIBERS, THROUGH THE EXCHANGE CORD CIRCUIT.

In the sleeve strand of the cord of each plug is connected a supervisory relay, which is energized only while current is flowing over the line to which the corresponding plug is connected; that is, while the receiver of that line is off its hook. These relays control the circuit of supervisory lamps, by the illumination or darkness of which the operator is enabled to ascertain the condition of the connected lines. On the right of this diagram is shown the ringing and listening keys. The former is a device for switching the alternating-current generator into the circuit of the calling plug and its connected line; the latter connects the operator's head telephone, which is shown near the center of the diagram, across the two sides of the cord in order to enable the operator to communicate with either subscriber.

The operation of this circuit and apparatus can best be understood by referring to Fig. 3, which shows two subscribers' lines equipped as already described and connected by a cord circuit at the central office. Consider the station at the left to be that of the calling subscriber and the one at the right to be that of the called. In the first place, the removing of the calling subscriber's receiver from its hook illuminates the line lamp, which remains lighted until the operator answers by the insertion of the answering plug into the answering jack. The operator, before inserting the calling plug into the jack of the called subscriber, must ascertain whether or not the line of that subscriber is already busy. This is automatically accomplished, for upon the touching of the tip of the calling plug to the ring contact of the multiple jack, she will hear a click in her head telephone if the line is busy, and no sound if it is free. If the line is free, she inserts the plug to its full extent, and presses her ringing key, which rings the subscriber's bell. As soon as the calling plug is inserted the supervisory lamp, shown at the right-hand lower portion of the figure, will be illuminated, because its circuit will be completed from ground through the battery, through the 90-ohm resistance coil and the lamp; thence through the third strand of the cord, the test ring contact of the jack, and to ground through the cut-off relay. This current will not only illuminate the lamp, but will operate the cut-off relay of the line called for as well.

As soon as the subscriber of this line responds, he will close the circuit between the two sides of his line and thus allow current to pass over the line to operate the transmitter. This current will pass through the supervisory relay, which will then close the low-resistance shunt circuit about the lamp and thus extinguish it. Both lamps are now out, and the operator pays no further attention to the connection until she sees one or both of the supervisory lamps again lighted. The corresponding lamp will be lighted when either one of the subscribers hangs up his receiver, which act will, by opening the circuit of the line, cause the corresponding supervisory relay to let go of its armature and thus remove the shunt about its lamp. When both lamps are thus lighted, the operator knows that the connection is no longer desired, and without further inquiry pulls down the plugs.



American Electrician

FIG. 4.—DIAGRAM OF CONNECTIONS BETWEEN TWO SUBSCRIBERS AT DIFFERENT EXCHANGES, THROUGH A TRUNK LINE.

It is evident that any fluctuation in the resistance of the current of a transmitter at one subscriber's station will cause a corresponding fluctuation of the current flowing in the line, and this fluctuation will pass through the two windings forming one side of the repeating coil, which will act inductively on the two windings forming the other side of the repeating coil and produce a corresponding fluctuation in the other line. This latter fluctuation will pass through the secondary winding of the induction coil and the transmitter at the subscriber's station and induce a corresponding fluctuation in the local circuit containing the receiver and the condenser.

One of the functions of this local circuit, which has already been referred to, is that of putting the receiver in inductive relation to the line without subjecting it to the passage of direct current through it, which circumstance might tend, if the receiver were connected up the wrong way, to demagnetize its magnets. This local circuit is, however, designed to accomplish still another result, this being the formation of a comparatively short path through which the fluctuations set up by the transmitter may more readily pass; in other words, it is supposed to act as the local circuit of a sort of booster to the outgoing telephone currents. The fluctuations in current caused by the transmitter pass through the condenser and primary winding of the induction coil, and thus induce in the secondary, which is in the line, fluctuations which tend to increase the fluctuations directly produced in the line by the transmitter.

So far, only such means have been described as would admit of the connecting of two subscribers whose lines terminate in the same exchange. Where several offices are used in the same system, the connections between subscribers in different offices are, as has already been pointed out, made by trunk lines extending between the offices. These trunk lines are spoken of as outgoing or incoming, according to which end of them is referred to. Thus an outgoing trunk line at one office would be an incoming trunk line at another. The outgoing trunk lines usually terminate in jacks in the regular sections of the multiple switchboard, while the incoming trunk lines usually terminate in plugs and cords and special apparatus, arranged at special incoming trunk sections, which sections are provided with multiple jacks in the same manner as the regular sections.

Fig. 4 shows a subscriber in one exchange connected through the local cord circuit at that exchange, and a trunk line, with a subscriber at another exchange. Assuming that the subscriber at the left has sent in a call, the operator at one of the regular sections of the switchboard will answer it in the ordinary way by inserting a plug into the answering jack, and having learned that the connection desired is for a subscriber in another exchange, she presses her order wire key and communicates over the order wire with the "incoming-trunk" operator at one of the incoming-trunk sections of the branch exchange. The incoming trunk operator repeats the order and gives the number of an idle trunk line to the operator at the first exchange. The incoming-trunk operator at the second exchange then tests the line in the ordinary way with the trunk line plug, and if it is found free she completes the connection by inserting the plug in the multiple jack of that line.

As soon as this is done, she sets the automatic ringing key, shown just to the left of her plug, which locks in the ringing position, because its controlling relay is not operated. The ringing generator is provided with an interrupter, each revolution of which switches the ringing current on to the line for one second and the 24-volt battery on to the line for five seconds. Thus the subscriber's bell rings for one second of every six until he removes his receiver from its hook. When he does this, the current from the 24-volt battery or from the ringing generator, whichever happens to be in circuit, passes through the primary magnet of the ringing key, and trips the latter into its normal position. By this means the bell of the subscriber is rung at intervals until he responds without any further attention on the part of the operator.

The insertion of the trunk plug into the jack of the called subscriber's line allows current to flow from the battery through the test relay and disconnect lamp, shown at the extreme lower right-hand portion of the figure, and thence through the cut-off relay to ground. This does not light the disconnect lamp, because that lamp is already shunted by the armature of another relay contained directly in the trunk line circuit, this latter relay having been operated by the insertion of the plug into the trunk line jack at the other exchange. As soon as the ringing key is tripped, the current from the battery at the incoming end of the trunk line flows through the metallic circuit of the subscribers' line to furnish current for talking. This operates the supervisory relay in the incoming cord circuit, and puts a ground on the sleeve side of the cord circuit at the first office, thereby operating the calling supervisory relay at that office, and this shunts the corresponding supervisory lamp and extinguishes it, thus notifying the regular operator at the first office that the subscriber has responded.

As soon as the subscriber called for hangs up his receiver, the supervisory relay at the incoming trunk section lets go of its armature and removes the ground from the sleeve side of the trunk line. This causes the calling supervisory relay at the first office to let go of its armature and remove the shunt from around the corresponding lamp. When both lamps of the regular pair of cords at the first office are lighted, the operator at that office pulls down the connection. By thus removing the calling plug from the trunk jack, current ceases to flow in the trunk line relay at the second office, which removes the shunt from the disconnect lamp at that office and allows it to be lighted for the first time. This is a signal for the incoming-trunk operator to disconnect.

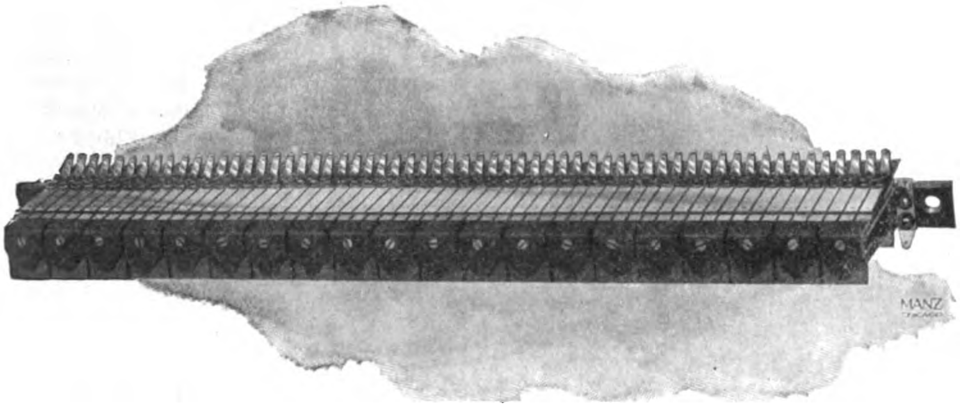


FIG. 5.—A STRIP OF TWENTY LINE RELAYS.

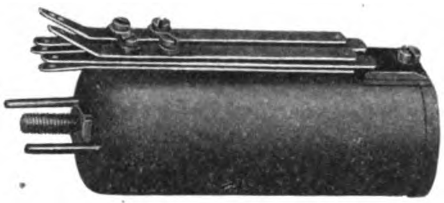


FIG. 6.—A CUT-OFF RELAY.

It will be seen from the above that when two subscribers are connected over a trunk line, they are under the control of the originating operator. The disconnect signals from both subscribers go direct to this operator, and it is not until she has pulled down this connection that the disconnect signal is given to the operator at the other exchange. The latter operator has no means of listening in on the circuit.

An interesting feature about such trunking systems is the means by which the incoming-trunk operator at the second office informs the calling subscriber and the regular operator at the first office that the line called for is busy. When she finds on testing that a line is busy, she inserts the trunk line plug into a "busy-back" jack, which jack has connected in its circuit a machine giving an interrupted current which gives a peculiar, familiar, and, to most subscribers, an extremely disagreeable sound. This sound is heard by both the operator and the subscriber at the first office, whereupon disconnection is made.

Fig. 5 illustrates the arrangement of line relays on a switchboard. As the illustration shows, these are mounted in "strips," the strip here shown containing 20 relays. Fig. 6 shows a single cut-off relay. The magnet of this is enclosed in an iron shell which forms a portion of the magnetic circuit. The armature of this relay, when attracted, causes the two long springs to break contact with the lower springs, and to make contact with the two upper springs. I may say, in passing, that all contacts in the best relays of this description are made of platinum. These relays are about 1¼ ins. in diameter, and the shells are of soft iron about ⅛ in. thick.

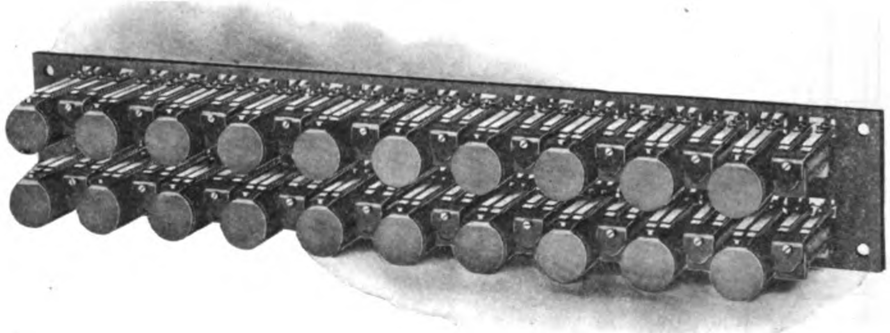


FIG. 7.—A STRIP OF LINE AND CUT-OFF RELAYS.

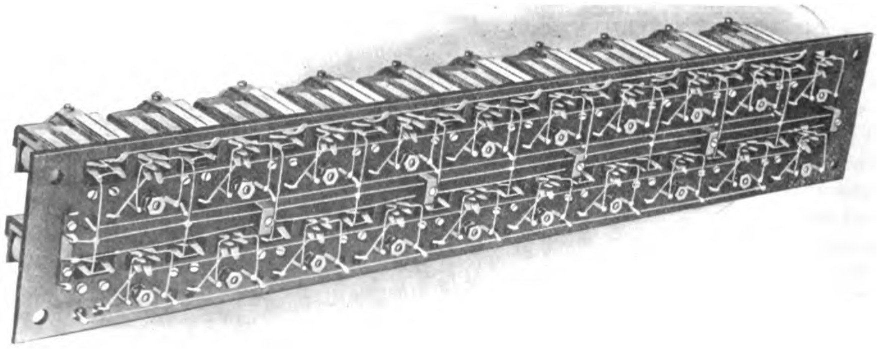


FIG. 8.—REAR VIEW OF LINE AND CUT-OFF RELAYS.

In the latest Kellogg exchanges the line and cut-off relays are mounted side by side on the same strip. Fig. 7 shows such a strip with twenty relays of each kind, the line relays being the smaller of the two. This strip represents a unit of twenty lines, which unit is carried throughout the entire scheme of wiring in the central office. Fig. 8 shows the other side of this relay strip, showing the connecting wires from the various terminals. These terminals pass through walls in the iron mounting strip and are readily accessible for soldering in the wires. In mounting the line and the cut-off relay in such close proximity, many of the wires which would otherwise have to be formed up in cables are reduced to the short, stiff bare wires clearly shown in this picture.

Coming now to the line signals themselves, in Fig. 9, I show a strip of drops, these being mounted on ½-in. centers so as to correspond to the spacing of the jacks. These were used before the adoption of the line lamp signals by the Kellogg Company, a strip of which signals is shown in Fig. 10. This strip is formed from a single piece of hard rubber about 10 ins. long and ½ in. thick. The lamps, one of which is shown in the front of the engraving, are so arranged as to slide into their sockets between the jack springs in such a manner as to make the proper circuit connections. In front of each lamp is a little lens, usually of opalescent glass, this lens being carried in a spun brass cap.

The advantages of the line lamp signal over the old form of mechanical signal are obvious, the principal ones being simplicity, cheapness and the fact that they may be removed instantly if found defective and replaced by good ones. A defective line lamp may be taken out and another one substituted in less than one-half minute. Another beauty of the line lamp is that when it is out of order it may be thrown away, which is much easier than repairing a mechanical drop. These lamps usually operate at 20 or 24 volts, take about ¼ ampere, and give approximately 1/3 candle-power. The calculated life of these lamps, with their present degree of perfection and with the average rate of use, is about thirty years, but, of course, this figure remains to be verified by actual service, for the telephone business is not yet old enough to prove the statement.

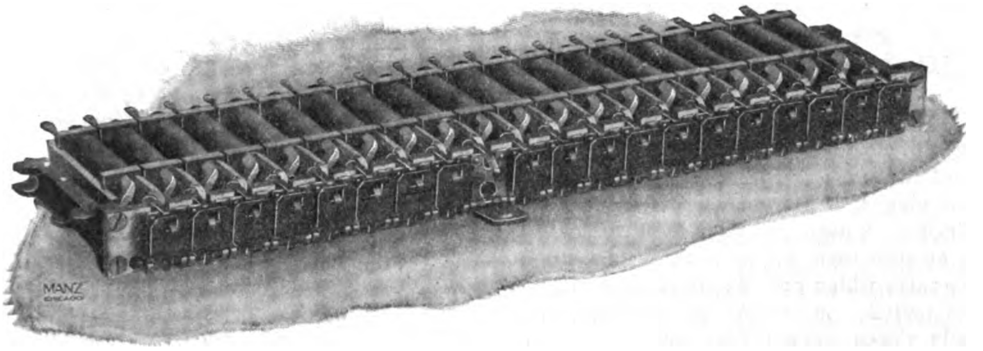


FIG 9.—A STRIP OF LINE DROPS OR ANNUNCIATORS

The next view (Fig. 11) shows a strip of ten supervisory relays, these relays being the ones used in connection with the cord circuit for controlling the supervisory lamps. These are ironclad, being enclosed by a shell precisely like the one used for the cut-off-relay. The armature, a disc of iron about 1¼ ins. in diameter, is suspended in front of the poles of the electromagnet by a thin leaf spring. The working parts of the relay, including the armature and contact points, are enclosed in a brass cap which locks on the shell with a bayonet joint.

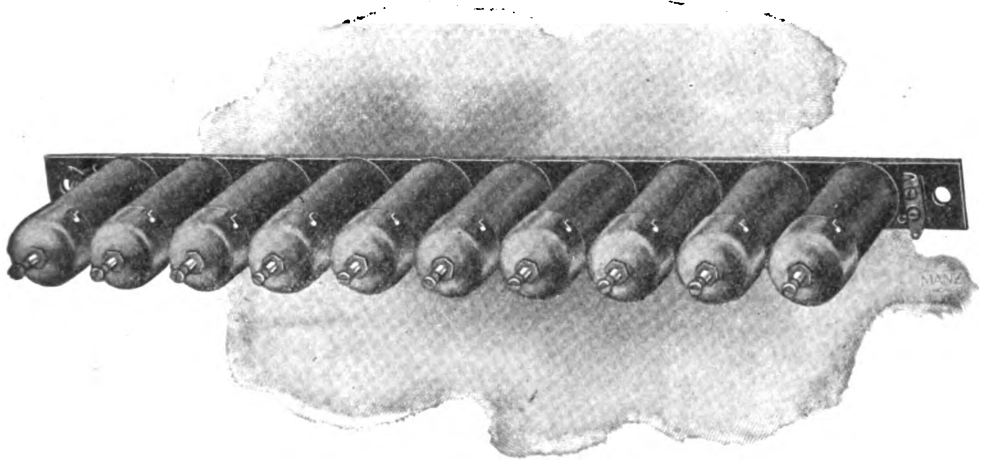


FIG. 11—A STRIP OF SUPERVISORY RELAYS.

I now show (Fig. 12) what is by all odds the most important piece of apparatus in a telephone exchange—the spring jack. This is a strip of the two-point jacks already referred to, and it will be seen that they are mounted twenty to a strip on spaces corresponding to those of the lamp jacks. The same spring jack is used for both answering and multiple. This strip is built up of hard rubber, brass and German silver, the front being a solid piece of hard rubber slightly over 10 ins. long drilled for receiving the sleeve contact. The rear of the strip is a piece of hard rubber milled to receive the line springs and the rearwardly projecting lugs from the sleeve contacts. This rear strip is reinforced by a heavy brass strip, into which the screws holding the line springs are threaded. In this particular strip the jacks are on ½-in. centers and the strip is 7/16 in. high. The spacing with this same construction may be readily reduced to ⅝ in. Where a smaller spacing than this is required, as in a board of extreme size, a somewhat different construction would be used.

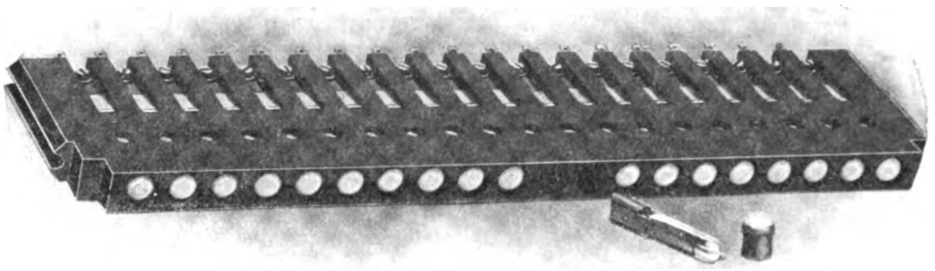


FIG. 10.—A STRIP OF SIGNAL LAMPS, USED INSTEAD OF DROPS.

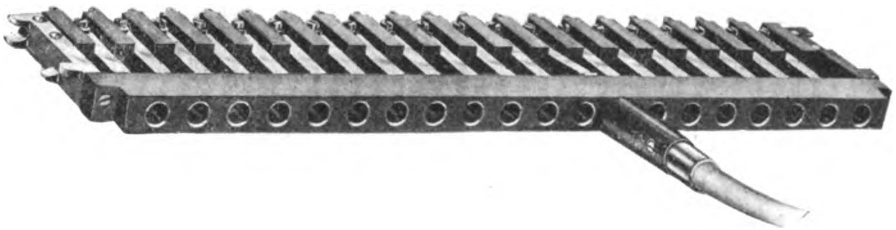


FIG. 12.—A STRIP OF SPRING JACKS; ONE PLUG INSERTED.

The design of telephone switchboards and apparatus is a matter requiring attention to almost infinite detail. Besides having a knowledge of the requirements of telephone service and a thorough appreciation of the engineering problems involved, the designer must have a peculiar faculty, which has been termed "telephone sense." Ability to distinguish between apparatus and circuits that will work successfully in practice and those that will work only in the laboratory is not acquired by all; and the problems are so remote from those of other branches of electrical engineering that it is seldom that a precedent can be found in any other branch.

◆

A Peculiar Combination.—In Southern California the use of water for both irrigation and power purposes recently gave rise to a peculiar combination of circumstances. In states where irrigation is necessary the laws usually provide that if a person or corporation discharges a certain amount of water into a stream at one point he is entitled to take an equal amount from the stream at some point lower down, less a certain allowance for evaporation and seepage. Thus a company owning land on the plains sometimes builds storage reservoirs far up in the mountains, turns water into a river there and takes it out of the river miles away from the point where it is put in. In the case in Southern California referred to above, a well was sunk near a river up in the mountains and the owner then bought electric power from a hydraulically-driven power station to pump water from his well into the river for irrigation purposes lower down. This water then passed through the turbines at the power house and so helped to generate the power which its owner paid to have supplied to him to pump the water. Further down the valley it was used for irrigation. The fall between the well and the power house being much more than the depth of the well, the power derived from the water at the power house was considerably more than the power required to pump the water.

Abstracts from Foreign Contemporaries

Direct-Current Brake Electromagnets.—To obtain a certain tractive force with an electromagnet, a relatively large number of ampere turns is required at the beginning of the attraction, since the magnetic lines of force pass through a long air-gap; while, after the air-gap is closed, only a very small number of ampere turns is required for holding the weight. Max Vogelsang describes in a recent number of the "Elektrotechnische Zeitschrift" the shunt brake electromagnets built by the Helios Company. In starting, a strong current is fed to the electromagnet, which current is considerably lessened when the armature is held by the magnet. In order to cut down the current after the brake has been started a special switch is used which is operated by the magnet itself. When the armature is almost at the magnet it actuates a switch which puts into circuit a resistance that was previously short-circuited. The magnet is shown in cross section by Fig. 2. A steel cylinder, *B*, is enclosed in an iron case, *A*. At *G* there is a simple valve which permits air to enter when the cylinder is raised, and is automatically closed when the cylinder descends. When the cylinder is raised it opens the switch, *S*, at the last moment, which switch is closed by a spring when the cylinder recedes. In Fig. 2 it will be seen that resistance is inserted in series with the magnet winding by the switch. Another resistance is always in shunt with the magnet coils which serves to receive the current of self-induction at the moment of disconnecting. The resistance inserted in series by the switch reduces the current to from one-eighth to one-sixth of its original value.

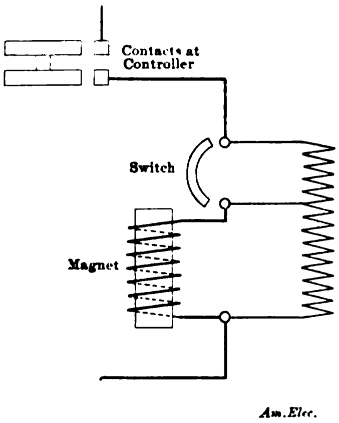


FIG. 1—BRAKE MAGNET CONNECTIONS

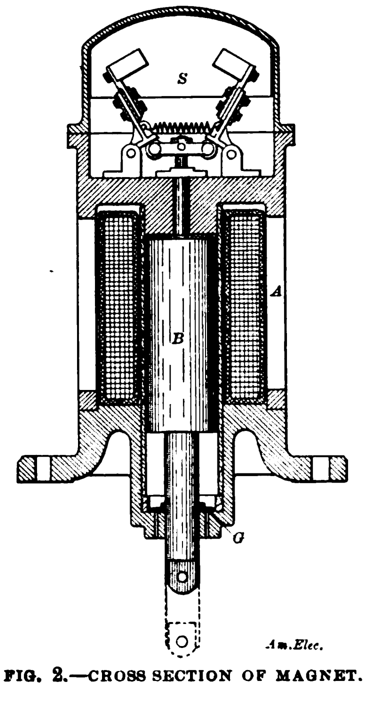
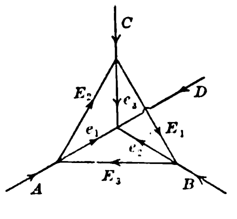


FIG. 2.—CROSS SECTION OF MAGNET.

Aron Meter for Four-wire Three-phase Systems.—H. Aron contributes to the "Elektrotechnische Zeitschrift" an illustrated article describing a modification of his well-known meter for three-phase systems having four electrical conductors. The meter reads correctly for star as well as for delta connections, and is independent of the differences in the load in the three phases. In Fig. 3, *A*, *B* and *C* represent the currents in the three main circuit wires; E_1, E_2, and E_3 the e.m.fs. between wires, and e_1, e_2 and e_3 the e.m.fs. between the fourth wire and each of the other three. The author shows that the power may be expressed by the formula, $W = A\ e_1 + B\ e_2 - C\ (e_1 + e_2)$, which is applied in his meter, the arrangement of which is indicated diagrammatically by Fig. 4. Three coils are placed side by side, and are supplied by currents, *A*, *B* and *C*, respectively. Two pendulums bearing potential coils oscillate above the three current coils so that each pendulum is acted on by two current coils. To the potential coil which is acted on by the currents *A* and *C* is applied the e.m.f. e_1, which is the e.m.f. between the phase *A* and the fourth wire, *D*. The other coil which is acted upon by currents *B* and *C* is at the potential e_2, which is the e.m.f. between the phase *B* and the fourth wire, *D*.



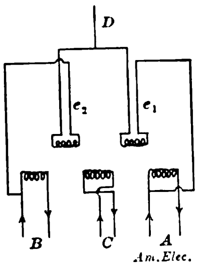


FIG. 3.—ARON METER CIRCUITS —FIG. 4.

Electrolytic Interrupter.—A recent issue of the "Elektrotechnische Zeitschrift" contains an illustrated description of an electrolytic interrupter which has been in successful use for some time past. It is a modification of the Caldwell interrupter. A china insulator, *a*, is suspended in a lead cylinder, *d*, by means of the lead rings, *c c*; the insulator has a hole, *b*, of about 0.06 in. diameter drilled in the bottom of it. A water-cooling cylinder, *e e*, surrounds the lead cylinder, *d*, which is the cathode, while a lead strip, *g*, is the anode which may be lowered or raised at will. Dilute sulphuric acid is used as the electrolytic. To prevent the spilling of the acid a bottle, *l*, having a hole in the bottom is inverted above the insulator. The interruptions occur at the hole, *b*, which connects the electrolyte in the cylinder, *d*, with that in the insulator, *a*. During the operation the author observed a peculiar periodical change of the level of the electrolyte in the insulator, which has an influence upon the successful operation of the interrupter.

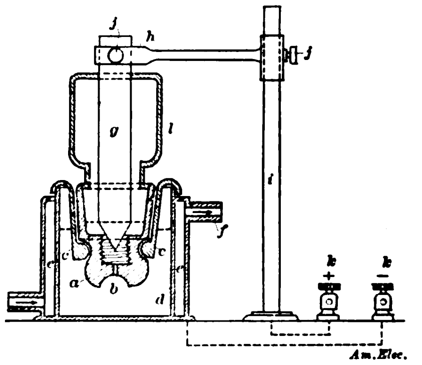
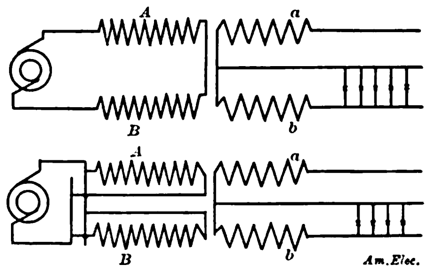


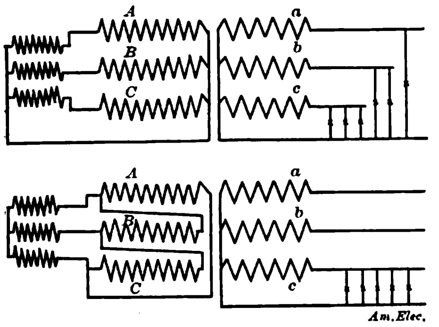
FIG. 5.—ELECTROLYTIC INTERRUPTER.

Transformer Connections—According to an article in the "Elektrotechnische Zeitschrift" in single-phase and three-phase plants where relatively few consumers scattered over large areas are to be supplied with light, the use of many small transformers being undesirable, a system similar to the three-wire direct-current system is often used, which leads to the use of so-called neutral conductors. In the three-wire single-phase system difficulties in transformer connections are met with; since if there are two cores and the connections are made as in Fig. 6, a great difference of voltage occurs when the loads in the two halves of the system are unequal. For instance, if the load in coil, *b*, is greater than that in coil *a*, the current in the primary coil, *B*, should be larger also; but this current cannot be obtained



FIGS. 6 AND 6A.—TRANSFORMER CONNECTIONS

in sufficient quantity, as it would also flow through the coil *A*, which has only a light load and the result is an entirely unsymmetrical distribution of the magnetizing and demagnetizing forces and magnetic flux. The voltage in *b* consequently decreases and that in *a* increases. The following remedy is recommended. Both high-tension coils are built for the full high-tension voltage, and are connected in parallel as shown in Fig. 6A. The load in the halves, *a* and *b*, may be entirely different, but the voltage drop is the same whether only one half or both halves are loaded. A somewhat similar arrangement is proposed for three-phase currents. The system shown in Fig. 7 in which the lamps are connected between the three phases and the neutral wire, has generally been used for low-voltage installations. For high-voltage the three-phase system shown in Fig. 7 A is used. It is sufficient for all practical purposes, to make the neutral wire half the diameter of the outers, as in the direct-current system.



FIGS. 7 AND 7A.—TRANSFORMER CONNECTIONS

Prony Brake.—F. Hubert describes in a recent issue of the "Elektrotechnische Zeitschrift" the Prony brake used by Siemens & Halske at their works at Charlottenburg. Fig. 8 shows the method of application. One end of the series of brake shoes is pivoted at *D* to the lever, while the other end is hung to the block, *B*, which slides in a curved slot in a lug on the lever. The grip on the wheel may be tightened or loosened, as the case might require, by the turnbuckle and a finer regulation is secured by turning the screw, *S*, which controls the position of the block, *B*. The lever is fulcrumed at *A* in the manner shown. The periphery of the wheel and the surfaces of the brake shoes are smeared with tallow; no water is applied to the friction surfaces, the brake discs being hollow and cooled by water within them. By reason of this method of cooling, the coefficient of friction and load fluctuations are almost nil. In order to secure a correct measurement of the brake horse-power it is necessary that the center *M* of the axle, the pivot at *A* and the point of application of the weight be in a straight line parallel with the ground line.

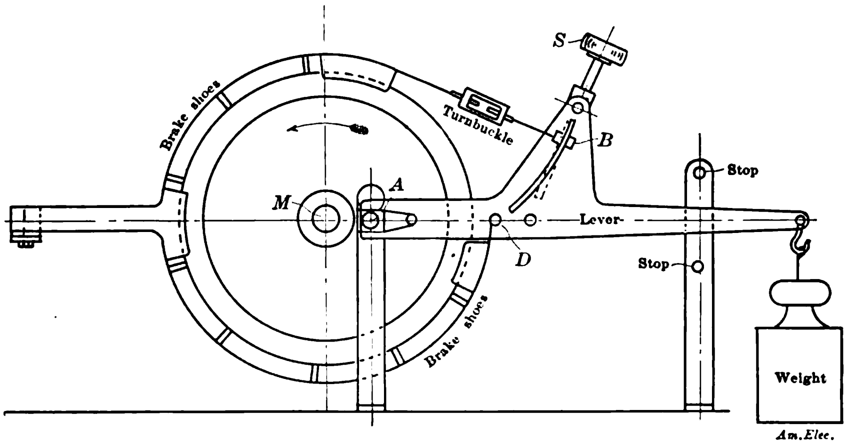


FIG. 8.—IMPROVED FORM OF PRONY BRAKE.

Outhenin-Chalandre Electrolytic Alkali Process.—This process for the production of alkalies and chlorine compounds by the electrolysis of solutions of sodium or potassium chloride is described by J. B. C. Kershaw in the London "Electrician." Fig. 9 is a sectional elevation of the cell, which consists of an outer vessel, *K*, and an inner vessel, *A*, entirely closed and built of materials not affected by the action of chlorine or its compounds. The inner vessel is filled with rows of porous-diaphragm tubes, *o*, *o*, open at each end to the outer chamber *K*, of the cell, and inclined at a slight angle, as shown. Each tube is hermetically sealed into the walls of the chamber *A* by a special device shown at *Z* and contains an iron sheet cathode running the whole length of its interior, which joins to a common terminal at *M*. Each vertical row of diaphragm tubes is thus served with current by one electrical contact. The anodes, *I*, are round rods of specially prepared carbon, fixed into the common lead head-piece *U*, and communicating at *e* with the negative terminal of the dynamo. They hang vertically in rows of seven between the rows of diaphragm tubes, and the chlorine evolved at their surface collects in the upper portion of the anode chamber, and is carried away by the outlet pipe *H*. The right-hand side of the inner cell is provided with a sheet-iron movable hood, *V*, and an outlet pipe, not shown. This serves to collect and carry away the hydrogen liberated within the diaphragm tubes and facilitates its utilization for other purposes. In operation the inner chamber, *A*, is filled with salt water and the outer vessel with a dilute solution of sodium hydrate. The chlorine liberated from the salt water passes off through the pipes, *H*, and is used for the manufacture of bleaching powder. The sodium liberated at the surface of the sheet-iron cathodes decomposes the water present, yielding hydrogen gas and a solution of sodium hydrate. The former is collected in the chamber *V*, and the latter collects at the bottom of the cell and is collected through the outlet pipe, *V*.

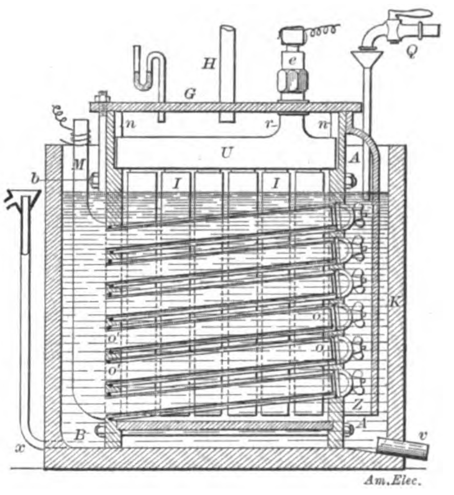


FIG. 9—ELECTROLYTIC ALKALI CELL.

Slip in Induction Motors.—To a recent issue of the "Elektrotechnische Zeitschrift" Georg Siebt contributes an article giving simple methods for measuring the slip in induction motors. If the armature has slip rings the armature current can be measured and this is a convenient means of measuring the slip. If an ammeter be connected between two slip rings, the needle oscillates near the average value at which it would rest at higher frequency, and for the same effective current; and if these oscillations are counted for a certain time the slip may be computed; it is equal to one-half the number of complete oscillations divided by the product of the time and the frequency of the primary current. A squirrel-cage armature admits of a simpler method, in which an artificial alternating current is made, having the same frequency as the armature current. The author elucidates the principle by the supposition that in the circuit of an incandescent lamp supplied at the same voltage as the motor, there is a switch which is opened and closed in synchronism with the frequency of the alternating current. In this case the lamp will burn continuously with a certain luminosity or will be entirely dark, depending on whether the voltage at the time during which the circuit is closed is at maximum or zero. The Joubert contact maker may be used as a switch; but if this is fixed on the axle of the motor under test, the closing and opening of the contact is not in synchronism with the alternating-current supply, on account of the slip. Assume at starting a maximum voltage, with a smaller voltage at the moment of the next contact, etc. The starting point is again reached when the motor is lagging by $\frac{1}{p}$ revolutions; *p* being the number of pairs of poles. During this time the incandescent lamp is supplied with an often interrupted alternating current of the frequency of the armature current. The lagging of the motor by $\frac{1}{p}$ revolutions corresponds to the lighting of the lamp twice. If the oscillations of the lamp light are counted per minute, the slip is readily found by the simple formula: slip $= \frac{y}{2\,p\,n + y}$ where y represents the oscillations in the light per minute; p, pairs of poles, and n, the number of revolutions made by the motor.

High-Tension Voltmeters.—A recent issue of the "Elektrotechnische Zeitschrift" contains a paper read before the Electrotechnical Society of Berlin by Herr Benischke in which the author describes the high-tension voltmeters of the Allgemeine Elektrictats Gesellschaft of Berlin. These instruments have two scales, one reading to 7500 volts, and the other reading to 25,000 volts. The first reading is taken on the ordinary static voltmeter while the second reading is obtained by means of condensers. The arrangement is based upon a suggestion of Peukert, who recommended reducing high-tension measurements to low-tension measurements by connecting several condensers in series and shunting one of them by a static low-tension voltmeter. As seen in the diagram, the author uses the same idea to obtain the second scale reading of 25,000 volts besides the original scale reading of 7500 volts. The dielectric of the condensers is micanite; the condenser is located in the base of instrument.

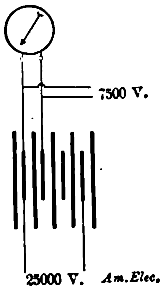


FIG. 10.

Storage Battery End-Coil Switch.—The switching of cells is not so simple a problem as might appear at first sight. One difficulty is the arrangement of contacts. If a single contact touches two contacts at the same time a cell is short-circuited and trouble arises. If the contact leaves one cell contact before it reaches the other the main circuit is broken and sparking occurs. This difficulty is easily overcome in hand-worked switches by using two contacts with a resistance between them, the resistance being low enough to allow the full load current to pass when subjected to a potential difference of two volts. But this arrangement does not suffice for an automatic switch if the mechanism is such that the resistance may be left in shunt to one cell for a considerable time. If the resistance is low enough to take the maximum current and it is left across a cell for a considerable time, that cell may be discharged at a rate greatly different from that of the remainder of the cells, to say nothing of the waste of power, which may be considerable.

Fig. 11 shows the Schneider end-cell switch as described in a recent issue of the London "Engineer." The potential difference between the points where constant e.m.f. is desired is measured by a voltmeter which has two contacts. These contacts open and close the circuits of two relays which control the motor that drives the screw shaft of the switch. In order to avoid short-circuits, the cell contacts are made double, with a guard resistance between them, and to avoid having the carriage stop with a cell short-circuited through the guard resistance the carriage is not connected rigidly to the screw, but has some longitudinal play in relation to it; this play is taken up normally by a spiral spring. A series of notches is provided, one for each cell, and the arrangement of the mechanism is such that the contact carrier goes by jumps, and always stops in register with the cell contacts.

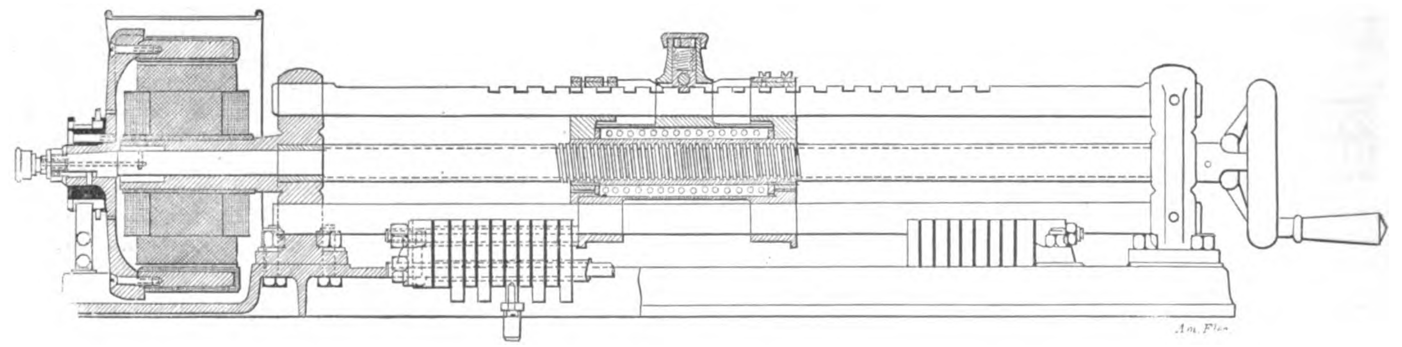


FIG. 11.—SEMI-SECTIONAL VIEW OF THE SCHNEIDER END-CELL SWITCH.

Some Recent Electrical Patents

Prevention of Cross Talk in Telephone Switchboards.—It is well known that the line drops, relay magnets, and other electromagnetic devices of a telephone switchboard are commonly arranged in parallel rows just as close together as mechanical conditions will permit in order to reduce to the smallest possible value the space occupied by the switchboard. In order to prevent mutual induction between neighboring magnets and consequent cross talk between the lines, it is customary to make these magnets of the tubular or iron-clad form. A disadvantage, however, of tubular or iron-clad magnets is that the impedance of the magnet is diminished by currents induced in the tubular shell; were this disadvantage reduced by splitting the shell then mutual induction between neighboring coils would be no longer prevented, and cross talk would result. Fig. 1 herewith represents an arrangement which has been patented by Frank R. McBerty for the purpose of obviating both of the disadvantages referred to. The subject of the illustration is an ordinary impedance coil, the core, g, of which carries a single coil of wire, h. The coil and both sides of the core, however, are enclosed in a copper tube, i, embracing the complete magnetic circuit. This sheath does not reduce the impedance of the coil as in the case of the ordinary tubular construction for the reason that it encloses both sides of the magnetic core, the effects of which are equal and opposite. The copper tube, however, tends to suppress the leakage of magnetic lines sidewise by reason of the currents induced in it by such lines. Patent No. 665,923.

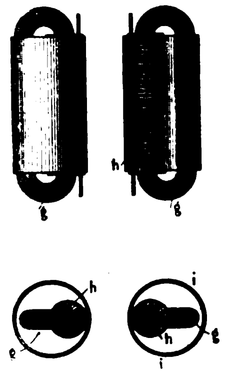


FIG. 1.

Polyphase Transformer.—It is well known that in transforming three-phase currents two transformers may be used instead of three, the primary terminals of the two transformers being connected to the three line wires exactly as two incandescent lamps would be connected to the wires of an ordinary three-wire system, and the secondary wiring similarly connected to the three secondary wires. E. W. Rice, Jr., has patented a single transformer which combines the two transformers used in this manner. Fig. 2 rep-

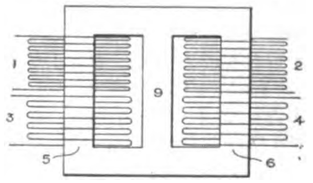


FIG. 2.—THREE-PHASE TRANSFORMER.

resents the arrangement, which consists of a core similar to that of a shell-type transformer, except that the central leg, 9, is of the same size as the two outer legs, 5 and 6. On the two outer legs the two primaries, 1 and 2, and secondaries, 3 and 4, are wound. As the phases of the magnetic fluxes are 120 degrees apart the resultant flux will be equal to each of the individual fluxes. It is for this reason that the central leg, 9, is given the same cross-section as the two outer legs, 5 and 6. The patent also includes a method of changing the secondary voltage by means of taps in the secondary winding, as illustrated in Fig. 3, the object of this arrangement being to provide a low voltage for starting an induction motor. Patent No. 669,662.

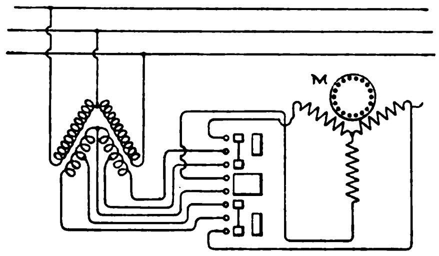


FIG. 3.—DIAGRAM OF TRANSFORMER WINDINGS AND CONNECTIONS.

Multiple Nernst Lamp.—This invention relates to a multiple-series arrangement of Nernst glowers, and is the subject of a patent issued to Alexander J. Wurts. Mr. Wurts states that in the manufacture of high-potential Nernst lamps it is usually undesirable to make individual glowers for a voltage higher than, say, 220. When the circuit e.m.f. is higher than this it is usually desirable to connect the glowers in series or in multiple-series. It is also advisable to use a small amount of resistance wire in series with the glowers to compensate for the reduction in the resistance of the glower as its temperature increases. Fig. 4 illustrates the arrangement patented by Mr. Wurts. The glowers, 16, are mounted vertically on opposite sides of a heat-resisting and non-conducting plate, 13. Each pair of glowers is connected by means of coiled wires, 17, having a positive temperature coefficient. The various pairs of glowers are connected in parallel to the terminals, 19 and 20. The heater is also mounted on the vertical plate, 13, and connected to the terminals, 10 and 11. The coils of resistance wire connecting the lower ends of the glowers are disposed in slots along the bottom of the vertical plate, and are thus prevented from coming in contact with each other. Patent No. 668,246.

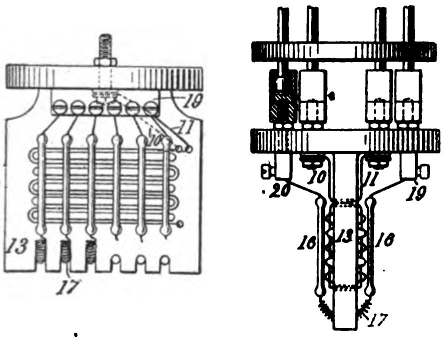


FIG. 4.—MULTIPLE SERIES ARRANGEMENT OF NERNST GLOWERS.

Third-Rail Electric Railway.—The arrangement of the third or conductor rail for electric railways has been made the subject of considerable thought, and numerous patents have been taken out covering methods of mounting the conductor rail and housing it in order to protect it from outside interference as well as to protect careless pedestrians from coming in contact with it. One of the latest methods of this class has been patented by Wm. T. Van Dorn, and is illustrated by Fig. 5 herewith. The conductor rail, *F*, is inverted and mounted in an insulating trough or continuous hood, as shown at the left of Fig. 5, the bolts which secure the rail in position being insulated by means of bushings and washers. The rail and its trough are mounted on the horizontal arms of a series of brackets or standards along the side of the roadway, as indicated in the main part of the drawing, and it will be evident that the conductor rail in this system occupies exactly the same position with relation to the collector shoe or trolley on the car that the ordinary overhead trolley wire does with relation to the trolley arm and wheel. The arrangement shown at the right-hand side of the truck is a safety device consisting of an insulated roller, *J*, mounted on an extension of the car-wheel axle; the brackets, *E*, on which the conductor rails, *F*, are mounted are of such a height that the insulated roller, *J*, is normally out of contact with the conductor rail, but the clearance is less than the depth of the flange on the car wheels, so that any tendency on the part of the wheel flanges to ride the track rails will be opposed by the roller, *J*, coming in contact with the inverted conductor rail. It is presumably proposed to put conductor rails on both sides of the track and extend both ends of each axle, putting a safety roller, *J*, on each end of each axle. Patent No. 670,651.

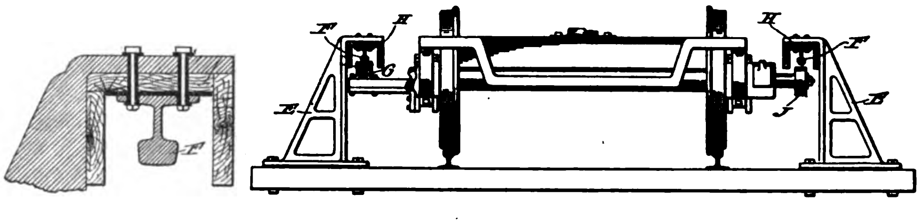


FIG. 5.—THIRD-RAIL ARRANGEMENT FOR ELECTRIC RAILWAYS.

Telephone Cord Circuit.—This invention, which has been made the subject of a patent to Charles E. Scribner, relates to central-energy telephone systems and dispenses with the impedance coils usually employed in association with the transmitter to prevent incoming talking currents from being short-circuited through the transmitter. The central battery, *a*, is connected across the cord circuit, through impedance coils, *b* and *b'*. The subscriber's transmitter is connected to two taps, each of which is midway of one of two windings disposed on a common core, *e*. The outer ends of these windings are connected to the circuit and the inner ends to the subscriber's receiver through a condenser. The two windings on the core, *e*, are in such position that if a direct current were passed through the entire winding both halves of it would magnetize in the same direction. The steady current from the central battery finds a circuit, of course, across the transmitter. Any increase in the resistance of the transmitter at one station tends to diminish the current through the windings, e^1 and e^2, and a momentary current is diverted into the receiver circuit, *r*, charging the condenser. The current flowing through the windings, e^3 and e^4, is then in the proper direction to induce an e.m.f. in the windings, e^1 and e^2, in opposition to the battery, tending to still further diminish the line current. A subsequent decrease in the resistance of the transmitter permits an increase in the line current and the discharge of the condenser. This discharge through the windings, e^3 and e^4, induces an e.m.f. in the windings, e^1 and e^2, which tends still further to increase the line current. The undulations in the line current, produced by the transmitter, therefore, are greatly amplified by the action of the condenser. Patent No. 669,710.

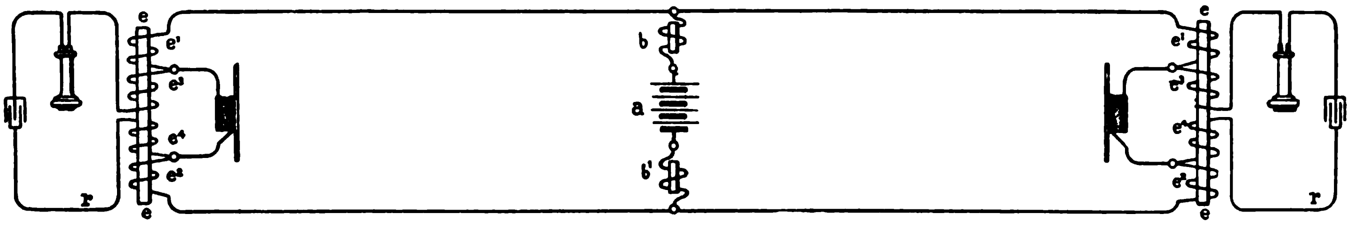


FIG. 6.—DIAGRAM OF CONNECTIONS, CENTRAL-ENERGY TELEPHONE SYSTEM.

The Heat Waste of a Gas Engine

To the Editor, American Electrician;

Sir:—In the editorial columns of your April issue there was a discussion of The Heat Waste of a Gas Engine, suggesting a means whereby the efficiency of the engine might be increased by utilizing the waste heat of the water-jacket. The writer wishes to state that the principle involved in this article has met with considerable consideration by inventors, chief among which are perhaps Tavernier, Patent No. 428,764 of May 27, 1900; Marrder, Patent No. 233,268 of October 12, 1880; Baldwin, Patent No. 270,748 of May 1, 1883; British Patent 7943 in 1892 to Sennett; British Patent No. 433 to Simon in 1878; German Patent No. 98,043 to Wultze; English Patent No. 1501 to Marchant, dated March 22, 1883, and English Patent No. 688 to Macgeorge, dated June 5, 1885. It might be stated, however, that the chief difficulty which these inventors have experienced lies principally in the fact that the temperature of the water-jacket under such conditions would be too high, commensurate with the requisite amount of temperature reduction for best results in the working cylinder and it has therefore been a matter of considerable experiment to accomplish the end which is set out in your editorial.

The writer, however, has gone somewhat deeply into this proposition and has designed an engine with the express purpose of not only recovering the waste heat of the water-jacket, but also that of the exhaust gases to a greater or less extent. As a result of an investigation into the heat losses by cooling the cylinder and the exhaust gases there seems to be considerable hope of reducing these losses sufficiently to increase the efficiency of the internal combustion motor from 18 to 25 per cent in engines of from 2 to 50 horse-power capacity and in a manner whereby the advantage gained in efficiency would have a corresponding advantage in the kinematics of the motor, putting it more on the level of a steam engine in this respect.

Pending applications for patents do not permit of any detail illustration of the apparatus, so that the writer is obliged to reserve any description which would interfere with the foreign patent applications. Philip K. Stern.

New York, May 9, 1901.

NEW BOOKS.

Induction Coils. Second Edition. By H. S. Norrie (Norman H. Schneider). New York: Spon & Chamberlain. Cloth; 282 pages, 4½ x 6½ ins.; 79 illustrations. Price, $1.

This is a welcome revision of Mr. Schneider's little book originally published five years ago. The only defect in the first edition was incompleteness, and this has been remedied in the present edition. There has been added a considerable amount of matter relating to gas lighting apparatus, wireless telegraphy and batteries. A most useful addition also is a table of dimensions of coils and condensers for various spark lengths. In its present form the book is a highly satisfactory and useful one.

Telephone Lines and Their Properties. By William J. Hopkins. Sixth Edition. New York: Longmans, Green & Co. Cloth; 307 pages, 5 x 7 ins.; fully illustrated. Price, $1.50.

This is the sixth edition of Prof. Hopkins' excellent work, and it contains a chapter on wireless telephony and composite telephone and telegraph systems, together with an account of recent developments in long-distance lines, in addition to the matter previously published. The older part of the book is a comprehensive discussion of the functions and properties of telephone circuits and the practical construction of overhead and underground lines. An annoying feature of the typographical make-up is the lack of figure numbers under most of the illustrations and conflicting numbers under the others.

American Street Railway Investments. New York: Street Railway Publishing Company. Cloth; 322 pages, 9½ x 12½ ins.; 29 maps. Price, $5.

This is the 1901 edition of the annual "red book" which has become the standard source of information to those interested in the financial development of street railways. The data contained in the book is singularly complete; one can but wonder how the compilers were able to persuade such a large majority of railway companies to supply the exhaustive information that is furnished here. This information comprises the capitalization, bonded indebtedness, annual receipts and expenses, size and character of equipment and the names of the officials of practically every road in the country. Besides this there are copies of the balance sheets of most of the companies and maps of twenty-nine of the more important systems.

NOTES.

Freight-Carrying Trolley Cars.—The statute book of the city of Detroit contains an ordinance which allows street railway cars to carry freight for compensation within the city limits.

Another Power Plant for Niagara Falls.—It is announced that work will be commenced at once on another power plant at Niagara Falls, to be located on the Canadian side of the river. The plans call for an initial development of 35,000 horse-power, and the plant is to be constructed under an agreement made by the Canadian authorities with the Canadian Niagara Power Company nearly two years ago. Under the terms of this agreement the power company must have the plant in condition by July 1, 1903, to develop, transmit and deliver 10,000 horse-power, and also have water connection made for the remaining 25,000 horse-power. The plant will be developed in co-operation with the plant of the Niagara Falls Company on the New York side of the river. The two power houses will be connected by cables so that either one can supplement the other whenever it may be necessary.

The International Association of Municipal Electricians. — The executive committee of this association, at a meeting held at Niagara Falls, April 27, set the date for the next annual convention at September 2, 3 and 4. Special rates will be secured from the hotels and railways, and information concerning these can be supplied within the next week or so upon application to Mr. Frank P. Foster, secretary of the association, at Corning, N. Y.

Long-Distance Test of the Telegraphone.—A test of the telegraphone was recently made over a telephone circuit between Boston and New York and it is said that the result was entirely satisfactory. Mr. Thos. D. Lockwood, of the Bell Telephone Company's staff, spoke into the instrument at the Boston end and the conversation was recorded by the telegraphone at the New York end, and subsequently reproduced with great distinctness.

Independent Telephone Convention.—The Independent Telephone Association of the United States of America will hold its fifth annual convention at the Pan-American Exposition grounds on June 11, 12 and 13. The program for the meeting has not yet been announced. Arrangements have been made with all the railroads passing through Buffalo to carry visitors to this convention at one and one-third fare for the round trip. The committee on arrangements is composed of Messrs. Samuel E. Wayland, of Scranton, Pa.; Robert R. Hefford, of Buffalo, and Clark L. Ingham, also of Buffalo. This committee will arrange for special rates at hotels for persons attending the convention.

A Long-distance Trolley Line.—A so-called belt line railway of unusual length is in course of construction in Maryland which, it is said, will be equipped with the overhead trolley system. The line is to extend from North East, Md., on the Chesapeake Bay, to Wilmington, Del., a distance of 32 miles, passing through Chesapeake City and Elkton, Md., and Newark, Del. Another circuit, 130 miles long, will be built and operated in conjunction with the line just mentioned. This will run from Wilmington to Rehoboth Beach, Del., on the Atlantic coast, passing through Delaware City, Del., Chesapeake City, Md., Cecilton, Md., Middletown, Bombay Hook, Dover and Milford, Del. The system is empowered by its charter to carry both passengers and freight, and it is stated that the schedule speed will be 25 miles an hour. The passenger cars will be vestibuled and have smoking compartments.

Electrical Equipment for Canal Boats.—According to a press dispatch, capitalists of Cleveland, Ohio, are financing a company the object of which is to operate a line of canal boats by electricity between Toledo and Cincinnati, Ohio. It is stated that the time of the trip between these two cities will be reduced to one-third of the present time, and that warehouses will be established along the line and extensive business carried on. The company will be known as the Miami & Erie Canal Transportation Company.

The Manhattan Elevated Motor Equipment.—The contract for electrically equipping the cars of the Manhattan Elevated Railway, of New York, has been placed with the General Electric Company. The equipment is to comprise 1600 car motors of 100 horse-power each, with the necessary controllers and accessories. There will be 800 motor cars, each car carrying two motors. There will be six cars to a train, four of which will be motor cars and the other two unequipped. The trains will be furnished with a system of control by means of which the motors can be operated from the platform of any car, as in the case of the well-known multiple-unit system.

Pan-American Exposition.- Director-General Buchanan of the Pan-American Exposition has set apart August 22 as Electrical Day at the Exposition. As the American Institute of Electrical Engineers will about this time hold a meeting at the Exposition which will be attended by a number of foreign electrical engineers, it is expected that the occasion will be made one of unusually great interest. It is intended to arrange some special electrical effects for that day which will be of interest from both technical and spectacular standpoints. The tests thus far made on the electric tower, electric fountains and other subjects of illumination have been extremely satisfactory, and these effects promise to constitute one of the greatest attractions at the Exposition.

A Cooling Tower of Brush and Twigs.—Cooling towers of various types used in connection with condensing steam engines are becoming so generally used that the characteristics of the more common forms and sizes are well known. Cooling towers built up of brush and twigs, however, are not so common, but where there is plenty of room this is a very cheap form of cooler, and from all reports appears to be rather efficient. A cooling arrangement of this kind is in operation at the power house of the Los Angeles-Pacific Railroad at Sherman, Cal., and it is interesting to contemplate the work done by this seemingly crude form of apparatus. The cooler consists of a timber framework 60 ft. long, 12 ft. wide and 13 ft. high, filled up with brush and twigs, and it cools the condensing water for a 300-h.p. compound Ball engine and a 460-h.p. compound engine of the same make, working on a railway load.

New York Electrical Society.—At a recent meeting of the New York Electrical Society Mr. Charles F. Scott, chief electrical engineer of the Westinghouse Company, delivered a most interesting lecture on the subject of induction motors. Mr. Scott explained briefly the characteristics of different types of alternating-current motors and then proceeded to an analytical discussion of the induction motor. The lecture was illustrated by means of large wall diagrams and lantern slides. Mr. Scott's lecture, like that of the one delivered sometime ago by Mr. Steinmetz, will be put into type for general circulation.

The South Carolina Inter-State and West Indian Exposition. — Active preparations are in progress for this exposition, which is to be held at Charleston, S. C., from Dec. 1, 1901, to May 31, 1902. Thus far nineteen States have arranged for representation at the Charleston Exposition, namely, Colorado, Connecticut, Georgia, Idaho, Illinois, Kansas, Maryland, Michigan, Missouri, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, Tennessee, Utah, Washington, and, of course, South Carolina herself. The Dominion of Canada and each of the Canadian provinces have also promised to make exhibits, and there will be exhibits from the West Indies. A feature of the exposition will be an Electrical Island on which will be an ornate pavilion and which, as its name indicates, will be the scene of special electrical effects. The heads of the various departments are J. C. Hemphill, Department of Publicity and Promotion; E. H. Pringle, Department of Ways and Means; E. L. Tessier, Jr, Department of Exhibits and Concessions; and J. F. Ficken, Department of Law and Legislation.

Submarine Boats.—In a lecture on submarine boats recently delivered at the Carnegie Lyceum, Mr. John P. Holland, inventor of the Holland boat, among other interesting statements said: "For transatlantic travel submarine boats will never be possible commercially. For short trips the submarine offers commercial advantages that will render it a dangerous rival of the surface-sailing vessel, if, indeed, it does not drive the latter entirely out of competition in certain waters. Take, for example, the trip across the British Channel. No other water journey causes an equal amount of suffering. The most hardened traveler becomes seasick there. Fogs and heavy traffic are constantly causing collisions. Storms toss the smallest boats about like cockle-shells. The submarine boat will remove all these objections. There will be no seasickness, because in a submerged boat there is no perceptible motion. There will be no smells to create nausea, for the boats will be propelled by electric power taken from storage batteries.

There will be no collisions, because the boats will travel coming and going at different depths, say, one at 40, the other at 60 ft. The water overhead may be crowded with small craft, but the submarine will have a free, unobstructed course. She will be kept absolutely true to this course by means of cables running from shore to shore. On these cables will run automatic steering gear attached to the submarine. Storms and fogs will have no existence for the traveler, for weather has little effect upon the water at the depth at which she moves. The appointments on such a vessel may be finer than anything on the surface. There will be no dampness, no stickiness. The passengers will enter a handsomely fitted cabin at Dover. Electric lights will make it cozy and bright. Neither the cold of winter nor the extreme heat of summer may be felt. The temperature under water varies but little the year round. Almost without jar the boat will put off from her dock on the English side. Practically no vibration will be felt from the smoothly running machinery. Before the traveler fairly realizes that a start has been made the boat will be fast at her dock at Calais. This is no dream. It is simply the forecast of a trip that I expect to take myself some day."

As to submarine boats in warfare he said: "When the first submarine torpedo boat goes into action she will bring us face to face with the most puzzling problem ever met in warfare. She will present the spectacle, when used in attack, of a weapon against which there is no defense. You can send nothing against the submarine boat, not even itself. You cannot fight submarines with submarines. The fanciful description of the submarine battles of the future have one defect. You cannot see under water. Hence, you cannot fight under water. Wharves, shipping at anchor, the buildings in seaport towns, cannot run away. The sending of a submarine against them means their inevitable destruction. To-morrow, if we had a fleet of submarines big enough, they could protect New York Harbor against an attack by the combined fleets of the world. But our shipping and our city would still be at the mercy of the enemy, if they had only one submarine, manned by a fearless crew of experts. You could not mine against her, for she would countermine. You could not close the harbor against her, even with a network of torpedoes and chains stretched across the Narrows, reaching from the surface to the bottom of the channel. From a safe distance she could send a torpedo against the network that would blow it to pieces, giving her all the passageway she wanted to go in and out. You could not chase her with a fleet of your own submarines, because you could not find her under water. How the menace of the submarine is to be met nobody has at this time been able to say. The genius of scores of inventors is grappling with the problem, but so far without result. All are agreed, however, that in one direction at least she will forever remain unconquerable. She will make a close blockade impossible."

ESTABLISHED 1889.

American Electrician,

WITH WHICH IS INCORPORATED

Electrical Industries.

CECIL P. POOLE, Editor.
W. H. ONKEN, Jr., Associate Editor.

Published on the first of each month by the

American Electrician Company,

NEW YORK: 120 Liberty Street.
CHICAGO: Monadnock Block.
PHILADELPHIA: 929 Chestnut Street.

JAMES H. MCGRAW, President.
A. E. CLIFFORD, Vice-President.
C. E. WHITTLESEY, Treasurer.
E. E. WOOD, Secretary.

Subscription, - $1.00 Per Year.
In the United States, Canada and Mexico.
FOREIGN COUNTRIES, $2.00.

NOTICE TO ADVERTISERS.

Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

IMPORTANT NOTICE.

Intending subscribers are warned not to place subscription orders with persons who cannot show written authority to take such subscriptions and make collections therefor, as the paper will not undertake to fill orders placed with alleged agents acting without such written authority.

Subscribers requesting a change of address should invariably furnish both the old and the new address.

Vol. XIII. JUNE, 1901. No. 6

The American Electrician has a larger paid subscription list than any other electrical journal in the world.

CONTENTS.

A Steam-Driven Electrical Transmission Plant, by J. R. Cravath.................... 251
Electricity in Coal Mining in the Pittsburg District, by Wm. G. Irwin.................. 255
Modern Practice in Steam Engine Construction 256
A Hint for Practical Engineers, by William D. Ennis, M. E...................... 264
A Few Common Boiler Troubles, by R. A. Douglass 265
The Choice of a Photometer for Central Stations, by Wilbur M. Stine.............. 266
Electrical Progress in Australasia, by Lawrence Birks 267
The Atlantic Avenue Station of the Boston Edison Company, by Alton D. Adams.... 268
The Arc Lighting Plant of the Hudson Electric Light & Power Company........ 278
The Modern Telephone Switchboard, by Kempster B. Miller........................ 282
Abstracts from Foreign Contemporaries.. 288
Some Recent Electrical Patents........... 290
The Heat Waste of a Gas Engine, by Philip K. Stern............................ 292
New Books 292
Notes 292
Editorial 294
A Simple Photometer....................... 296
Testing Consumers' Meters at New Orleans 299
Common Battery Telephone Systems, by W. S. Henry 300
The Sprague Multiple-Unit System, by Edward Chilton 302
Boiler Feeding Steam Pumps, by C. W. Obert 304
Comparative Testing of Fan Motors, by S. D. Gilbert 307
Lessons in Practical Electricity............ 307
Letters on Practical Subjects.............. 308
Electrical Catechism 311
Queries and Answers...................... 312
Gould Railway Car Lighting System....... 313
A Broad Motor Switch Patent............. 314
New Apparatus and Appliances............ 315
Personal ....Adv. 81
Trade Publications ....Adv. 81
Business News ....Adv. 82

Combining Small Generating Stations.

Electric lighting stations supplying the needs of small towns when properly managed usually give fair returns on the investment, but because of the small size of such plants a great many of them are unable to command the services of a manager who is fully qualified to cope with the conditions which must be skilfully met in order to obtain maximum earning ability. In some few cases a stockholder in the company possesses the requisite executive ability, and the company is correspondingly benefited; such companies are unusually fortunate. Any plan that will put the small plants not thus favored on a more satisfactory basis of operation will not only be gratifying to the stockholders of those particular plants, but will mean much to the electric lighting industry in general. A suggestion as to one method of improving the investment value of small neighboring stations is found in the description of the Santa Monica plant, which forms our leading article this month. This plant delivers current to sub-stations in towns more or less neighboring, which sub-stations have displaced very small and necessarily inefficient individual generating stations.

The chief argument in favor of the distribution of power by means of electric motors instead of using small steam engines is that a large generating plant can produce power at a cost so far below the best possible result from a number of small ones that the saving more than pays the cost of the double conversion. The same argument applies with equal force to the case under discussion. A generating plant of 3000 kilowatts output can obviously produce that output for very much less money than five separate plants of 600 kilowatts output each, considering merely the fuel consumption and depreciation. Add to this saving the economy effected in attendance and it becomes evident that the total saving will cover the interest and maintenance on a good deal of transmission line and apparatus. The total cost of the plant will be considerably greater, of course, than the cost of individual plants, but there are many cases, like that in California, where the ultimate saving and increased efficiency of service would amply justify the consolidation of generating plants. It should be remembered, too, that the establishment of a polyphase transmission system between the several towns of a group renders practicable the handling of heavy power loads, such as municipal pumping plants, which could be profitably carried.

The comparative newness of high-voltage transmission will tend to deter many from considering a plan of this kind; it will take some little time for engineers who are unaccustomed to transmission work to be convinced of the practicalness of the scheme, to say nothing of the views of bucolic dignitaries concerning pole lines carrying thousands of volts. The newness referred to, however, is rapidly wearing off, and bucolic dignitaries are—with painful slowness, be it said—having the scope of their vision widened by dint of strenuous effort on the part of more progressive people, so that it is not too much to hope that the initiative of the California company will find followers in the immediate future. There is no reason why high-tension transmission should be restricted to water-power plants and extensive railway systems.

◆

The Standard Power of Incandescent Lamps.

Just why the standard candle-power of incandescent lamps should have remained all these years at 16—a figure commensurate with nothing in particular—does not seem to be explicable by any process of logic, any more than the retention of the accidental standard of 110 volts. To be sure, there is no particular objection to 16 candles as a standard except that there is no reason for it, while there are some valid arguments in favor of other standards. Lamps of 10 candle-power, for example, would supply better distribution than those of 16 candle-power in places where only a few lamps are required, and multiples of 10 give a better gradation in sizes than multiples of 16.

In Europe 8 candle-power is substantially the standard unit; if this figure is practical there, why is not 10 so over here? For comparison with the average gas jet a 20-c.p. incandescent lamp is much more appropriate than one of 16 candle-power. In plants of moderate size, therefore, where gas competition is a vital factor, 20 candle-power would be a more effective unit, and 10-c.p. lamps could be used for the smaller customers who desire two or three lamps to illuminate areas that cannot all be reached from that number of sources. Of course we are aware that lamp makers supply lamps of almost any candle-power that may be desired; it is not a question of manufacture, but one of judgment on the part of central station men. It is also a matter of common knowledge that 20-c.p. lamps are made; it is not so well known, however, why either they or 10-c.p. lamps have not superseded the present standard, and we confess to considerable curiosity on the subject.

Central Station Practice.

The two central stations described elsewhere in this number are of much interest as illustrations of the advance that has been made in the design of generating plants since these stations were first established. There is nothing startling or radically new in either of them; they simply represent modern practice in this branch of engineering, and represent it very well. A significant feature of the Boston station is that there is disclosed an incipient tendency toward the use of alternating current for supplying the outlying districts. While the use of a double-current generator can scarcely be considered the acme of modern engineering, the recognition by one of the principal direct-current advocates in America of the advisability of combining direct-current and alternating-current service in a large plant is a distinct step forward. Neither reason nor (granted rational premises) logic indicates that either of the two systems alone is adequate or commercially preferable in a central station as large as the one in Boston, while it is almost obvious that the use of both will increase the flexibility and efficiency of the plant.

The Hoboken station is almost at the other extreme of current practice, the only direct-current equipment besides the exciter dynamos being the arc-light apparatus and the small starting motors for bringing the synchronous motors up to speed. The results of the tests of the synchronous motor and arc dynamo sets show very high combined efficiencies; although the averages are about 76 and 78 per cent for the two sets tested, there is every reason to believe that if the motors could have been operated at full load, the efficiency would have been around 80 per cent. Without going into minute details of operation it seems that somewhat better results could be obtained either by the use of steam engines for driving the arc dynamos or by using alternating-current arc lamps supplied with current directly from the main bus-bars through constant-current regulators. Driving the dynamos by means of engines, however, would mean either the use of comparatively small and inefficient engines or belting all of the dynamos from one engine—no one would tolerate a line shaft around a modern station—which is highly impractical. And the use of alternating-current arcs fed through constant-current regulators would, in this plant, mean limiting each circuit to 40 lamps, which would be a serious inconvenience and expense, 900 lamps being operated. So the thing seems "about as broad as it is long," and it is highly problematical, all points considered, whether any gain would have been effected by adopting either of the plans mentioned in place of the motor-dynamos.

The "moral" furnished by both of these stations is obviously that the exigencies of the service demanded from central stations of any magnitude cannot be met adequately by either alternating or direct current alone. There are, of course, many stations from which only one of the two classes of current is distributed, but the fact remains that whenever such a station serves large and sparse areas and has a mixed character of load, the unused class of apparatus could be added to conspicuous advantage.

A Short Talk to Engineers

A great many operating engineers are highly intelligent men who never intentionally miss an opportunity to increase their store of knowledge, who are not satisfied with merely being on the alert for practical "kinks" but are also always trying to "find out why." This class needs no urging or incentive, and it is fortunate for the stockholders of any plant when the engineer of that plant is one of the kind mentioned. At the other extreme is the class that work—or pretend to work—solely with a view to drawing their pay at the regular interval and who scuttle out the moment the clock indicates the end of their daily shift. This class is not worth consideration. There is an intermediate class, however, that arouses one's sympathy by reason of their short-sightedness. The men of this class have ample inherent ability, good judgment as far as it reaches, and are almost invariably men of ripe experience. But they are prevented by some one of several deplorable impediments from advancing beyond the stage at which they become members of their unfortunate class.

One man of this class is afflicted with the insane idea that there is no need to learn any more than he already knows; usually such a man also greatly overestimates the extent of his actual knowledge. Another man belittles the value of what he contemptuously terms "all this theoretical stuff," and a third has reached a lazy state superinduced by a good job the requirements of which have remained within his ability for a number of years, and he consequently does not keep up with the march of improvement going on outside. All three men manifest the most stubborn and unreasoning opposition to any progressive tendency that threatens to carry their plant beyond their rut of knowledge, ignoring the fact that although they may temporarily impede progress it will inevitably undo them in the long run. It is a great pity that men of this kind cannot apply to themselves the lesson of the downfall of others of their class; they never do—on the contrary, they calmly rate their less fortunate brethren in a class several grades below their own, and refuse to be warned. The only remedy that we can suggest is continuous, unremitting study and the analytical perusal of every available scrap of literature relating to their branch of work. Men who are not overloaded with a sense of their perfection, who are not lulled into a false feeling of security by "having it easy," and who devote their spare time to absorbing the theory despised by the unwise are always found at the top of the ladder; assuming, of course, good habits.

Short Cuts to Knowledge.

There are many ends that are considered to be attainable by means of "short cuts," ranging from the acquisition of wealth to the salvation of one's immortal soul. But however feasible theft or death-bed repentance may be, it is a most inflexible fact that "short cuts" cannot be applied to the accumulation of knowledge; and the sooner this is realized by the class of beginners who want to acquire understanding without work, the better off will they be. We are continually requested to name "a good book that tells all about" some technical branch of learning "without any mathematics"; requests are also received almost daily for explanations of this, that or the other thing "without using algebra." The favorite subject is the principles of alternating currents and alternating-current apparatus. Now we are always glad of an opportunity to help a beginner, but it is an utter impossibility to explain properly any action of alternating currents or alternating-current apparatus without the use of algebra. The formulas are perfectly simple in most cases, however, and any intelligent boy of sixteen could, unaided, master sufficient algebra and elementary trigonometry to understand them, if he really wished to do so. Beginners must face the fact that the study of elementary mathematics is indispensable if they ever expect to know anything really worth knowing about electrical apparatus.

A SIMPLE PHOTOMETER.

The importance of making photometric measurements of incandescent lamps in order to determine their initial candle-power or its variation during lamp life is too well understood to require discussion. At the present time the agents of the various lamp companies find it not only profitable but necessary to carry a portable photometer around with them to prove the statements they make to customers, while the manufacturers of scientific instruments have a constant demand for photometers of various sorts (precision, portable or central station types).

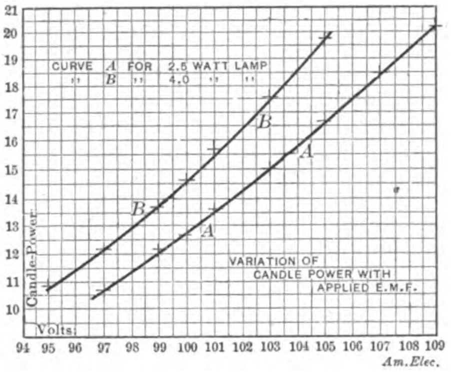


FIG. 1.

In the design described below advantage has been taken of the plan of photometry by the same-circuit method which was described quite fully in the American Electrician for October, 1899, to which the reader is referred for detailed information. By the use of this method some very serious difficulties in the way of successful commercial photometric measurements are avoided. A very brief review of the important points of the method will be in order just here.

If a standard incandescent lamp is at one end of a photometer bar and a lamp whose candle-power it is desired to measure is at the other end, these two lamps may be compared by lighting both from the same circuit (that used for regular lighting) without the aid of storage batteries or special appliances for procuring constant e.m.f.; and no difficulty will be experienced due to fluctuations in the e.m.f. of the supply circuit. Putting it another way, when the grease spot in the car has been so set that it becomes invisible, it will stay invisible in spite of fluctuations in the voltage of the supply circuit. This can only be done if the increase in candle-power of both lamps for a given rise in voltage is the same.

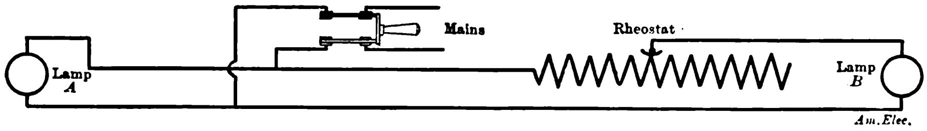


FIG. 3.—ELECTRICAL CIRCUITS OF THE PHOTOMETER.

If they are of equal efficiency (watts per candle) this will be true; but if not, it is not true. The extreme divergence which is likely to be met in practice is when one of the lamps compared takes 4 watts per candle-power while the other takes 2½ watts per candle. Fig. 1 shows two curves plotted from results of measurements made on two lamps from the same maker of the same nominal candle power (16), but of the two different efficiencies named. In the vicinity of normal candle-power the 4-watt lamp varies 0.98 candle-power per volt of change in the e.m.f. while the 2½-watt lamp varies 0.85 candle-power per volt of change. Most incandescent lamp standards have an efficiency of 4 watts per candle-power, but wherever 2½-watt lamps are used the fluctuation in voltage on the circuits would never be over 1 per cent; and so, even if one were comparing 2½-watt lamps with 4-watt lamps in a candle-power measurement by the same-circuit method, fluctuations in e.m.f. would produce less effect on the accuracy of the measurements made than the personal element, which can never be eliminated. In work with lamps of the usual efficiencies on circuits to which they are adapted, the change of candle-power in proportion to applied e.m.f. holds wonderfully well; and in working with a photometer like the one herewith described I have been unable to observe any effect produced on the results, even when the voltage fluctuated 5 or 6 per cent.

In Fig. 2 is shown an elevation of the photometer complete. It will be seen that the instrument is not portable, but on the contrary is a substantial affair, designed to be mounted once for all in the position where it is to be subsequently used. The heavy base board, 1⅛ ins. thick., 8 ins. wide, and 7 ft. 4 ins. long, is supposed to be supported by two brackets against a side wall at such height that the car is at the level of the eyes. The car travels on a run-way made of two ½-in. iron pipes or rods which should be smooth and straight. Cold rolled iron rod does very nicely. The car, shown in detail in Figs. 5, 5-a and 5-b, and described later, is mounted on these rods and a range of travel is provided so that candle-powers between 4 and 36 may be measured. This makes it possible to use the instrument for both 16 and 32 candle-power lamps, but a decreased accuracy will be found when measuring the latter sort.

At the right-hand end of the track the rheostat is placed, which is only in series with the lamp at the same end. Near the lamp at the left end is shown a switch which controls the supply of current to both lamps. In practice I have found it desirable to make this switch double-throw, so that when the lights on the photometer are cut off others may at once be turned on to provide the requisite illumination for adjusting or changing apparatus. No attempt has been made to show the wiring of the photometer except as Fig. 3 gives it. It is exceedingly simple and anyone who uses the plan here shown may easily make an arrangement of wires to suit his own taste. The absence of any binding post connections for voltmeter, ammeter and wattmeter are worth noting; I have purposely omitted them. The reasons are set down along with some remarks on the operation of the photometer near the end of the article.

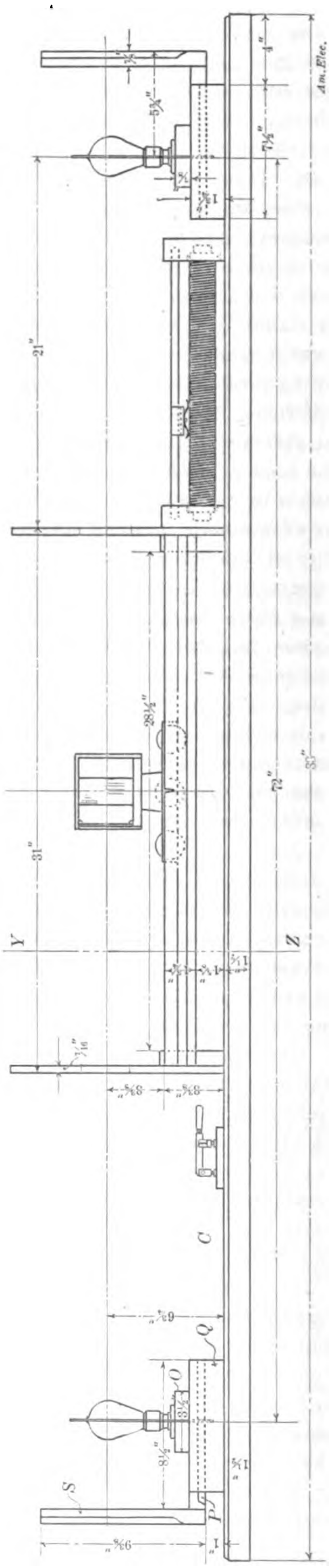


FIG. 2.—ELEVATION OF THE COMPLETE PHOTOMETER; ONE-TENTH ACTUAL SIZE.

If any instrument is to be used it may be placed at the position marked *C*, where its scale will be illuminated by the lamp at the left-hand end of the bar.

Proceeding to details, Figs. 5-a and 5-b show parts of the car. The sides, top and back of the box are made of ¼-in. lumber; the bottom is made stronger. In each side, as shown at *M*, a circular hole 2 ins. in diameter is cut. Against the left side, at *D*, the grease spot screen is placed (the plan view shows it at *L*). At the back is a wooden block of the form shown by the plan view; and a mirror is mounted against the inclined surface, *G* (marked *F* in the elevation). This mirror is to show a reflection of the grease spot and surrounding paper to an observer who looks into the car from the front. It should be of first quality mirror glass and adjusted in place so that the whole of the image shows and is centrally placed.

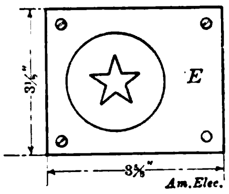


FIG. 4.

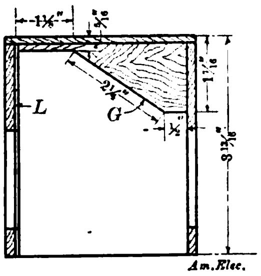
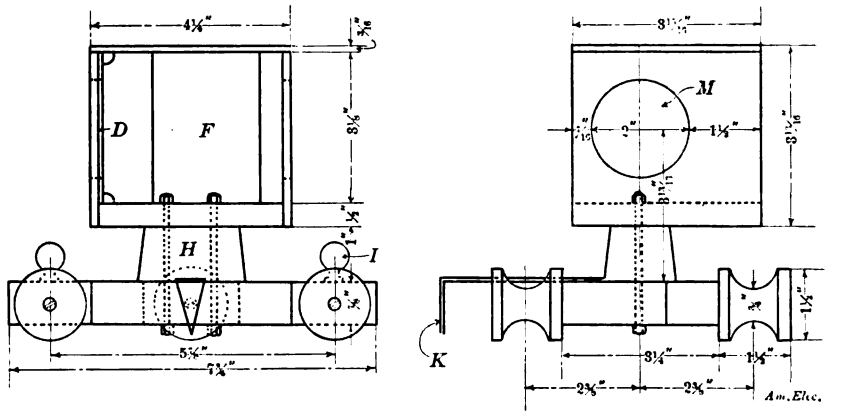


FIG. 5.



FIGS. 5-A AND 5-B.—THE CAR.

The grease spot screen (see *E*, Fig. 4), is made of two pieces of sheet metal, about No. 14 B. & S. gauge, through both of which a 2-in. hole is cut to match the opening in the side of the car when the screen is slipped into place. Between the two pieces, which are held together by screws, is placed the paper with the grease spot in the form of a star upon it. The grease spot is in this form so that by having a long line to separate the spot and surrounding paper field, the best possible opportunity may be given to determine the disappearance of the difference in the color of the spot and that of the field. The paper need not be of any particular kind. It should be white, not too transparent, and with both sides as nearly alike as possible. A linen typewriter paper marked Berkshire Hills No. 109 on the package and Gloria Linen in the water mark, I have found very satisfactory. The part containing the water mark should not be used.

To make the grease spot, first cut from ⅛-in. thick brass plate a star of about the size which might be inscribed in a circle of 1-in. diameter, and mount it on a rod set perpendicular to the star. Melt a little paraffine over a water bath; put the star into the bath until it is thoroughly warmed; lift it out and drain it of superfluous oil and then set it down on the paper which is laid on a piece of blotter. A little practice will enable one to make grease spots with sharply defined edges and themselves quite translucent; from which the very best may be selected for use in the car. The screen may be slipped in place behind cleats as shown in the elevation (Fig. 5-a), or one of the metal plates may be omitted and the paper be secured in place against the wooden side of the car by screwing down over it the single piece of sheet metal.

The completed car is mounted on rollers for which porcelain knobs are used of form and size which may readily be procured from an electrical supply house. The knobs turn on wood screws set into a ⅞-in. pine piece which is shaped a little to give it a neat appearance. A knob may be put on as shown to take hold of when moving the car. This piece carries a solid block of lead, *H*, which is put in to give the car stability on the track and at the same time give it a proper elevation. A pointer attached to the base frame as shown indicates candle-power as readings are taken. This pointer is to be set just at the middle of the car or perhaps more exactly 1⅞ ins. to the right of the paper carrying the grease spot.

TABLE I.—FOR THE CONSTRUCTION OF A CANDLE-POWER SCALE.

Candle-power mark on scale.	Distance from standard in inches.	Distance to the right from first mark.		Candle-power mark on scale.	Distance from standard in inches.	Distance to the right from first mark.	
		Exact inches.	Nearest 64th inches.			Exact inches.	Nearest 6ith inches.
4	48.000	0.000	0.000	17½	35.195	12.805	12 13/16
4½	47.050	.950	61/64	18	34.938	13.062	13 1/16
5	46.183	1.817	1 13/16	18½	34.695	13.305	13 5/16
5½	45.390	2.610	2 39/64	19	34.454	13.546	13 35/64
6	44.658	3.342	3 11/32	19½	34.220	13.780	13 25/32
6½	43.969	4.031	4 1/32	20	33.994	14.006	14—
7	43.334	4.666	4 43/64	20½	33.771	14.229	14 15/64
7½	42.736	5.261	5 17/64	21	33.555	14.445	14 7/16
8	42.179	5.821	5 53/64	21½	33.345	14.655	14 21/32
8½	41.648	6.352	6 23/64	22	33.142	14.858	14 55/64
9	41.143	6.857	6 55/64	22½	32.941	15.059	15 1/16
9½	40.665	7.335	7 21/64	23	32.742	15.258	15¼
10	40.213	7.787	7 25/32	23½	32.550	15.450	15 29/64
10½	39.779	8.221	8 7/32	24	32.363	15.637	15 41/64
11	39.360	8.640	8 41/64	24½	32.179	15.821	15 53/64
11½	38.966	9.034	9 1/32	25	32.000	16.000	16—
12	38.585	9.415	9 27/64	26	31.652	16.348	16 11/32
12½	38.216	9.784	9 25/32	27	31.319	16.681	16 11/16
13	37.864	10.136	10 9/64	28	30.994	17.006	17—
13½	37.529	10.471	10 15/32	29	30.687	17.313	17 5/16
14	37.200	10.800	10 51/64	30	30.390	17.610	17 39/64
14½	36.885	11.115	11 7/64	31	30.100	17.900	17 29/32
15	36.581	11.419	11 27/64	32	29.823	18.177	18 11/64
15½	36.285	11.715	11 23/32	33	29.554	18.416	18 27/64
16	36.000	12.000	12—	34	29.295	18.703	18 45/64
16½	35.723	12.277	12 9/32	35	29.043	18.957	18 61/64
17	35.454	12.516	12 33/64	36	28.800	19.200	19 13/64

The scale itself is mounted on a strip of wood shown in Fig. 2 and again at *N* in Fig. 6, so that the pointer indicates candle-power directly. To construct this scale take a strip of fine bristol board about 1¼ ins. wide and 21 ins. long. Beginning about 1 in. from the left-hand end of this strip put a mark and then go on with others spaced to the right at distances from the first given by column 3 of the accompanying table. The candle-powers of column 1 are to be put opposite the proper marks and the scale is complete. It is well to make the marks with waterproof india ink and then give the card a coat of white shellac. After the 25-c.p. mark is passed, the half-candle-power intervals are not calculated; the distances between the marks indicating even candle-powers are too short to make this worth while. The values given in the table are computed for a photometer bar measuring exactly 6 ft. between lamps, and a 16-c.p. standard. If the numbers therein set down are to be made use of, these conditions must hold good. The figures of column 3 are obtained by subtracting each one of those in column 2 from 48. Those in column 2 were computed directly from the fundamental law of photometry which states that the intensity of light varies inversely as the square of the distance from its source. For example, if there are two lamps, one at each end of a photometer bar, and the grease spot screen is so placed that the difference in color between the spot and the surrounding paper cannot be detected, then calling one lamp *A* and the other *B*

$$\frac{\text{candle power of A}}{\text{candle power of B}} = \frac{(\text{distance of screen from A})^2 *}{(\text{distance of screen from B})^2}.$$

Values were assigned to *B* and the corresponding distances from the standard

---

*Let *A* be the standard lamp, of 16 candle-power; represent the unknown candle-power of the tested lamp by *B*; the distance from the screen to this lamp by *Db*, and the distance from the screen to the standard lamp by *Da*. Then

$$\frac{A}{B} = \frac{16}{B} = \frac{Da^2}{Db^2}.$$

As $Da + Db = 72$ ins., $Db^2 = (72 - Da)^2$. Hence

$$\frac{16}{B} = \frac{Da^2}{(72 - Da)^2},$$

and $B\,Da^2 = 16\,(72 - Da)^2$.

$$\therefore \sqrt{B}\,Da = 4\,(72 - Da), = 288 - 4\,Da$$

$$\therefore 4\,Da + \sqrt{B}\,Da = Da\,(4 + \sqrt{B}) = 288,$$

and $\frac{288}{4 + \sqrt{B}} = Da.$

lamp to the screen were calculated. It is these which are given in column 2 of the table.

The scale should not be set in place until after everything else has been entirely completed. When it is put in position proceed as follows. Mark a place on the wooden scale support just 3 ft. from each lamp or just half way between them. Now if the pointer on the car were just under the grease spot, the 16-c.p. mark on the scale should be put at the mark just made, but since for some constructive reasons the pointer is put 1⅞ ins. to the right of the screen, the 16-c.p. mark must be also displaced this same amount to the right of the mark which has been put on the support for the scale. The scale must be securely fastened in place so that changes in atmospheric conditions will not bulge the scale away from the support. It may be glued fast or supported firmly at the center and constructed so it can expand freely both ways.

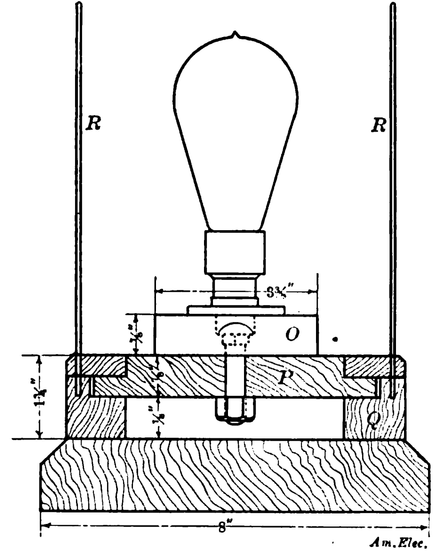


FIG. 7.—LAMP STAND

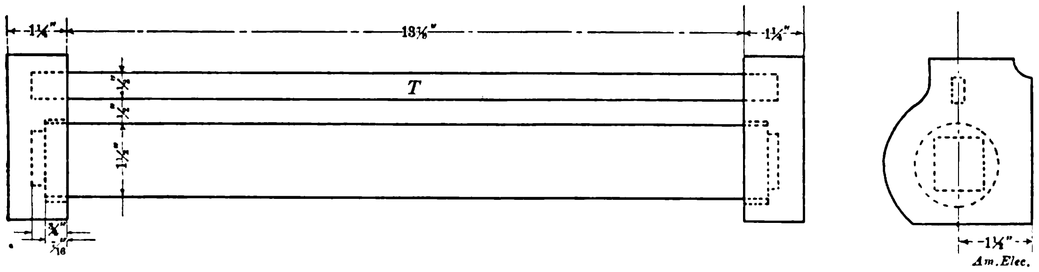


FIG. 8.—SOME DETAILS OF THE RHEOSTAT.

Fig. 6 shows a section through the photometer on the line, *Y Z*, of Fig. 2, facing the left. The ½-in. rods pass through a ⅞-in. block and rest against the large wooden screen placed and shaped so as to cut off all direct light from the lamps to the eyes of the observer. If these screens are made of 7/16-in. lumber as shown, they must, of course, be strengthened by having a thin piece scarfed in to cross-grain with the large piece. It will be obvious that this whole piece could quite as well be made of sheet metal.

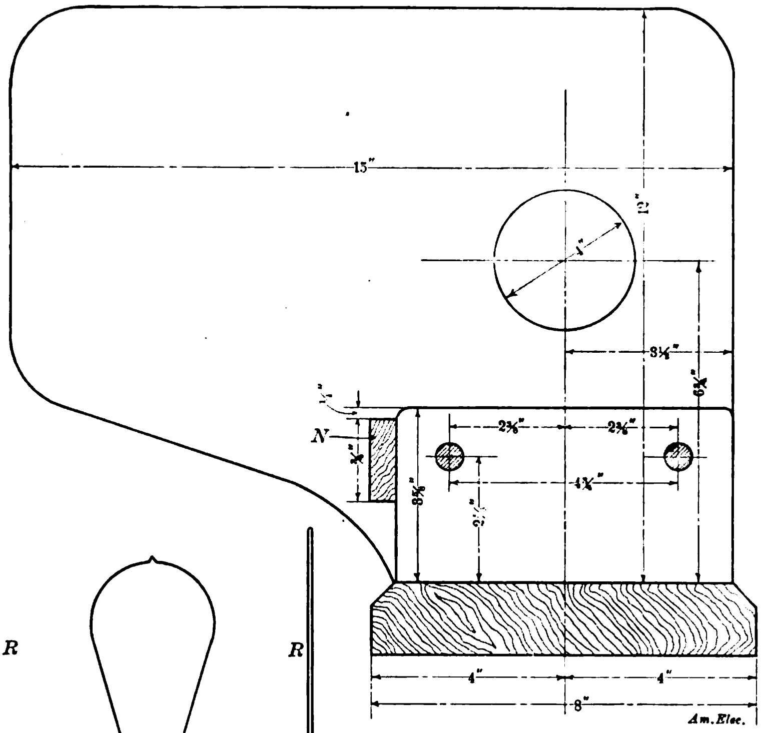


FIG. 6.—CROSS-SECTION.

In Fig. 7 are shown some details of the lamp stand which do not appear in Fig. 2. It is a section through the center of either lamp across the photometer. For the sake of simplicity and interchangeability, both lamp stands are made alike Since the particular form of construction followed is most useful at the left-hand end, the description is to be understood to apply especially to that. Two pieces, *Q*, are to be securely fastened to the baseboard, as shown, with their top edges cut to received a piece, *P*, with edges rabbetted so that strips screwed to *Q* will produce gentle friction between them and *P*. A block, *O*, is secured by a bolt to the piece, *P*, so it, with the lamp mounted on it, may be turned on the bolt as an axis, but not too freely. The block, *O*, is circular in form and has a mark on one side which can be brought over any degree mark on a scale fastened to *P*, just under it.

The scale is marked to give every 30 degrees around the circle. A lamp receptacle like No. 1180 of the Bryant Company's make is mounted on block *O*. This is adapted to receive a lamp with a T.-H. base. Adapter No. 9357 of the General Electric Company's make will screw onto this and make a socket for lamps with Edison bases, while by the exercise of a little ingenuity a similar adapter to fit the photometer for lamps with Westinghouse bases can be made. The wires, *R*, give a means for determining when the lamps have their centers exactly at the right distance apart. They are driven into the blocks, *Q*, at both ends of the bar in such a position as to be always exactly 6 ft. apart and also properly placed with reference to the candle-power scale. A piece, *S*, made exactly like the piece, *P*, except that it is 1 in. longer, made also of ⅞-in. stuff is secured at right angles to *P* as shown in Fig. 2.

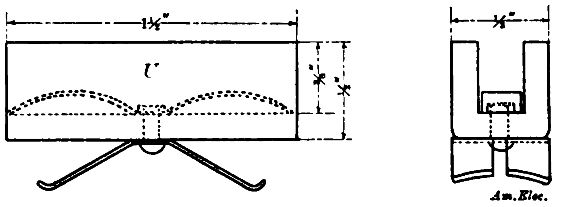


FIG. 9.—RHEOSTAT SLIDER.

The method of constructing the rheostat is shown in Figs. 8 and 9. All of the parts shown are of hard wood, except the pieces, *T* and *U*; these are both of brass. The piece, *U*, goes in place on *T*, and German silver springs connect the rod with a coil of wire which is put over the hard wood cylinder. In order to have a satisfactory winding, proceed as follows: Turn up the cylinder and square off the ends as shown. Wrap it with a piece of thin asbestos paper in a couple of layers, sticking it fast with shellac varnish. After the shellac has thoroughly dried into the asbestos, a close spiral of No. 20 double cotton-covered German silver wire is to be wound from end to end of the cylinder.

Thoroughly shellac the coil after winding and fasten both ends down, either by tying them fast or soldering the last two or three turns at each end together. These ends will be hidden in the recess provided in the end pieces when the construction is finished. When the shellac is quite dry, rub off the insulation over a path about an inch in width with sandpaper, so procuring a place for the contact piece, *U*, to ride along and made electrical connection to any turn of the solenoid. It may happen that after the first sandpapering, the strip where the insulation has been cut off may have to be re-shellacked, dried, and again sandpapered, to cut down the fuzz of the cotton threads and make a good contact by the spring piece possible. These springs must be very carefully fitted, as the success of the rheostat depends more on them than anything else. One ampere may be sent through this rheostat indefinitely and 10 volts regulation on a 16-c.p. lamp is very readily procured in almost imperceptible steps.

After the whole instrument has been assembled it must be painted all over with a dull black paint. Black shellac will do if the gloss is cut after it has dried. The wall behind the photometer must also be painted black or covered with a strip of black cloth.

Let us assume that the instrument is built and installed in a plant which operates at 112 volts constant potential, uses 3½-watt lamps and has a fluctuation in voltage of 2 per cent under ordinary running conditions. Before any measurements can be made a couple of standard lamps must be purchased. These should be marked with the candle-power they give at 112 volts (the working potential of the plant). Suppose No. 1 is marked 16.5 candle-power and No. 2 marked 15.6 candle-power, both at 112 volts and when standing in a designated position (usually indicated by an arrow at the top of the lamp which is to point directly down the photometer bar to the grease spot).* The operator puts No. 1 in the left-hand socket, moves the socket so that the lamp center is exactly in line with the two vertical wires at that end of the bar, and the arrow pointing to the grease spot. He next puts a 3.5-watt 110 or 108-volt lamp in the right-hand socket, placing it in proper position with reference to the vertical wires there. A 3.5-watt lamp is selected for this, because those to be tested are 3.5-watt lamps.

The car is now set at the 16.5 candle-power mark, lights turned on and with eyes on the reflection of the paper and grease spot in the mirror, standing squarely in front of the car, the operator adjusts the rheostat until the spot disappears. Standard No. 2 now takes the place of No. 1 and the car is moved backward and forward from a place where the grease spot looks darker than the surrounding paper to one where it looks brighter and back again until the limits are narrowed down and a balancing point is found where the grease spot does not show at all. The candle power opposite the pointer is now read off. It should come within 2/10 of 15.6 candle-power, and repeated readings would give 15.6 as the average of the readings made. Always keep the eyes squarely in front of the car as it is moved and do not look at the candle-power scale until the position of balance is determined.

If there is trouble in doing this there had better be an eye-piece like those used on stereoscopes fitted to the car. The standards have now been checked against each other and one may proceed to measurements of other lamps for service on the 112-volt circuits. Notice that no voltmeter readings whatever are necessary. The switchboard voltage is maintained at about 112 and is subject to its usual fluctuations. Even if one owns a good voltmeter there is really no use in connecting it. In most photometers a very accurate voltmeter is required; the needle must move without lag or friction and special calibration is frequently necessary.

The lamp at the right-hand end of the bar becomes the working standard for further work. Put a lamp whose candle-power it is desired to know in the socket at the left-hand end and by moving the car find a balancing point for it. Read the scale and its candle-power is determined at 112 volts. Proceed in this way with all the lamps to be measured, returning occasionally to one already measured once, to get a check reading. Once in awhile a standard lamp should be inserted in the left-hand socket to get a check on the candle-power of the working standard. In all work where the measurement is required within a ¼ candle-power, at least three readings should be taken and an average be struck if they run nearly alike. If the readings come different, either the observer's eyes are not sufficiently sensitive for the work, the grease spot is defective, or the observer is not giving his sole attention to reading the car and so gets too much bright light in his eyes from outside sources to make fine discriminations between the color of the spot and that of the field possible. Two people should always work together on photometer work, one to read the car only and the other to make adjustments and change lamps.

The plan of operation which has now been described makes it possible to determine candle-power in a room which is not really a dark room. Any small amount of light which does reach the photometer must be constant, however.

Since the watts per candle can only be computed after the candle-power is measured, and when the wattmeter reading is taken at exactly the right voltage; and since for many purposes the candle-power measurements are of even more importance than the efficiency measurements no attempt has been made to incorporate into this photometer a means for measuring the watts which a lamp uses. Various plans with inexpensive apparatus may be applied to this determination after the candle-power measurement has been made and I prefer to separate the two.

We have then an instrument of fair accuracy, capable of use on circuits for commercial lighting. If it is intended to be used for measuring lamps of various e.m.fs., a second rheostat is required and an accurate voltmeter.

One other difficult matter in the use of this photometer is yet to be met. In order to ascertain the mean horizontal candle-power within any reasonable length of time, it should be done at one reading by the aid of a "rotator" driven by some source of power. The least expensive rotator I know of which is good for anything would cost twice as much as the photometer described in this article. Here is a plan of measurement which I have used with fair success which requires no rotator at all. A lamp having a filament of a given type has a fairly constant ratio between the mean horizontal and the end-on candle-power. If this ratio is known therefore, instead of measuring the candle-power of a lamp in the position in which it stands in Fig. 2, after standardizing the working standard at the right-hand end in the manner already described, the operator may pull the frame, *P S*, out of its slides, and turning it over enter *S* instead of *P* into the grooves which fit it, and measure the end-on candle-power of the lamps.

Put a lamp of unknown candle-power into the socket, move the stand into position so the luminous center of the lamp is in line with the vertical wires *R* and measure its candle-power (the rheostat having previously been set for the working standard). Multiply the value obtained by the ratio of horizontal to end-on candle-power and the result is the mean horizontal candle-power. To illustrate the amount of error involved by such proceeding I give in Table II a set of values for 12 lamps; 6 of each of two common types, selected at random from a large number of the same sort. All were marked 16 candle-power and were tested at marked voltage.

TABLE II.—RATIOS OF MEAN HORIZONTAL TO END-ON CANDLE-POWER.

Type.	Lamp No.	Mean Horizontal candle-power.	End on candle-power.	$\frac{\text{mean hor. c.p.}}{\text{end on c.p.}}$	Average Ratio.
Double Filament.	1	17.7	5.3	3.34	3.263
	2	17.7	5.5	3.22	
	3	18.1	5.6	3.39	
	4	18.2	5.5	3.41	
	5	17.3	5.4	3.20	
	6	18.1	6.0	3.02	
Long Coil Anchored.	1	19.3	6.8	2.83	2.47
	2	18.1	7.5	2.41	
	3	17.4	7.3	2.38	
	4	17.5	7.1	2.46	
	5	16.4	7.0	2.34	
	6	18.1	7.5	2.41	

◆

TESTING CONSUMERS' METERS AT NEW ORLEANS.

Progressive managers of electric light central stations are coming to realize more and more the importance of frequently checking up the accuracy of consumers' meters for the purpose of preventing both injustice to consumers and loss to the company by reason of meters running slow, as they are extremely likely to do when left without attention for many months. The dust that works into a meter case and the wear on the jewel all tend to make meters run slow, and if the instrument has a commutator, dirt on the commutator enhances the lagging in speed. The loss of revenue from this cause may be a large percentage of the gross earnings and eat up all the legitimate profit.

The Edison Electric Company of New Orleans has a very complete system of checking up consumers' meters. All meters, whether new or not, are tested for accuracy before being sent out to consumers. This is done in the company's meter testing laboratory with the aid of a battery of 125 small storage cells which supplies current to the armature circuit and a single large storage cell to supply the series winding of the meter. In this way but a small amount of energy is required to test meters of large sizes. The indicating wattmeters, voltmeters and ammeters used for testing are carefully compared with standard instruments at frequent intervals. The meters on the consumers' lines are, of course, read every month. Every other month the reader takes off the case, cleans the commutator and renews the jewel if it appears necessary. These jewels are brought back to the office and ground true to be used again.

---

*The General Electric Company will supply standard lamps of about 4 watts per candle, marked as described and with the candle-power at a designated voltage on the label.

Every six to eight months the consumers' meters are checked from a portable meter which is taken to the place by the tester. This portable meter is checked every morning at the laboratory before starting out. The meter tester carries in his buggy as many sizes of portable meters as there will be sizes of meters to test on his circuit on that trip. The portable test meter is hung from the case of the meter to be tested by hooks which have turnbuckles in them so that the portable instrument can be leveled. The comparison of the consumers' meter with the test meter at several different loads is done by comparing the number of revolutions of the two meters, which should be the same. The use of the recording wattmeter in this way has the advantage over the use of an indicating wattmeter and stop watch in that it does not require two men to do the testing, and there is less liability to error in observation.

COMMON BATTERY TELEPHONE SYSTEMS.

BY W. S. HENRY.

The principle of a common battery system, patented by S. B. Fowler, is shown in Fig. 12. An exchange circuit and two stations, *A* and *D*, are shown as they would be connected during a conversation; all bells, signaling devices, keys and switches are omitted for the sake of simplicity. Current for the transmitter flows from the battery at the central exchange through line 2, the primary of the induction coil, and the transmitter, to ground and back to the battery. The talking current induced in the secondary of the induction coil has a complete metallic circuit (excepting one condenser at each station) through which to flow. This metallic circuit through which the talking currents flow contains no repeating or choke coils. However, if the same battery is used to supply more than two circuits, a choke coil would have to be inserted at the point, *I*, between the common battery and each cord circuit at the switchboard in order to avoid or reduce cross talk. Moreover, since the battery current, while talking is going on, flows through only one of the two line wires, there would probably be considerable trouble from cross talk unless a third wire, twisted spirally around line 2, was used in place of the ground return, which would be very undesirable on account of the extra expense, except, perhaps, in small interior systems where the circuits are very short.

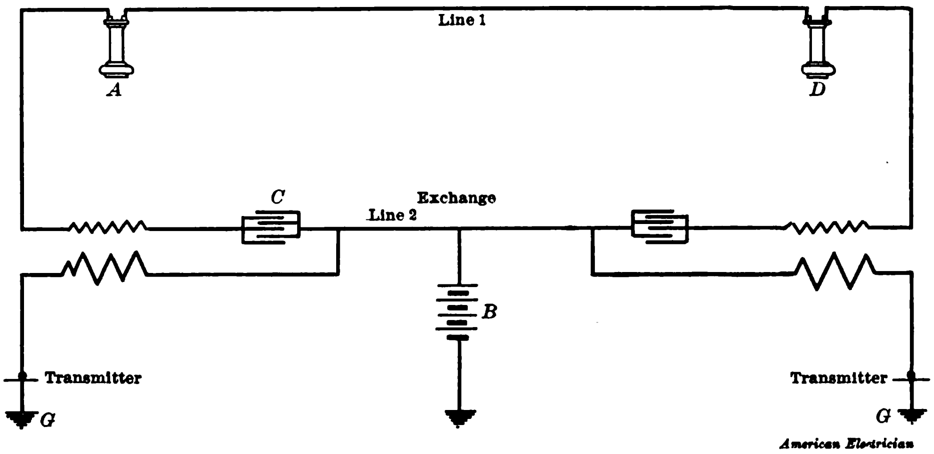


FIG. 12.—PRINCIPLE OF THE FOWLER COMMON-BATTERY SYSTEM.

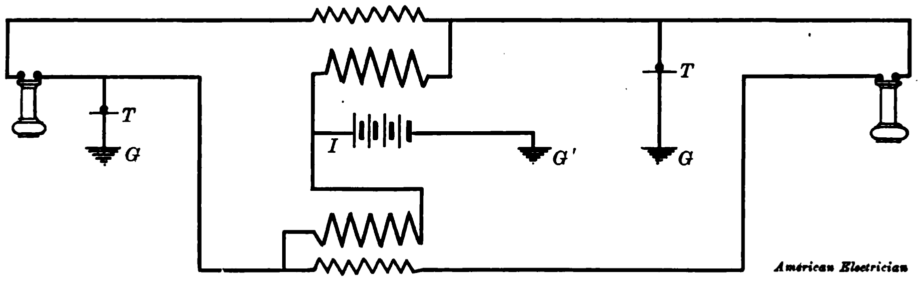


FIG. 13.—FOWLER SYSTEM WITH CENTRAL INDUCTION COIL.

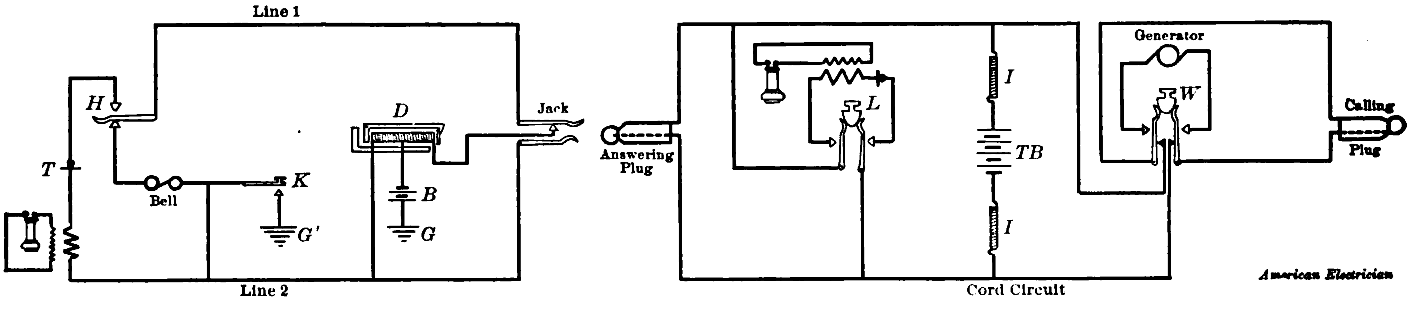


FIG. 14.—ONE OF THE BELL COMPANY'S COMMON-BATTERY SYSTEMS.

In this system even the induction coil may be placed at the exchange, as shown in Fig. 13. Thus by placing the induction coils in the cord circuits only one for each cord circuit is required instead of one for each subscriber's instrument. The condensers shown in Fig. 12 are not necessary and are omitted in Fig. 13. In this diagram one common battery supplies all circuits, but when several sets are supplied a choke coil would probably be necessary at *I* in each pair of cord circuits.

A common battery system, the principles of which have been explained in a previous article is shown in Fig. 14. When the receiver rests on the hook a high resistance bell, at least 1000 ohms and preferably 2500 to 5000 ohms in resistance, is connected across the two line wires at the subscriber's station. When the receiver is removed from the hook the bell is disconnected and in its place across the line wires there is connected a transmitter, *T*, and the primary winding of an induction coil. The secondary of the induction coil and the receiver are in a local circuit which is permanently closed. The use of the calling key, *K*, which is normally open but makes a connection to the ground, G^1, when pressed, will be apparent presently. The annunciator, *D*, at the central office is differentially wound and so connected that if a current were to flow from one line wire through it to the other line wire the iron core would not be magnetized, and hence the shutter would not drop. Moreover, if by any means just a trifle more current should flow in either half of the winding than in the other half, the permanent magnet, *ns*, so polarizes the core that the shutter would still be held up. Hence, the drop is not so sensitive as to be always falling if it is a little unbalanced.

Now, between the central connection of the drop winding and the ground, *G*, there is a signaling battery, *B*. When the subscriber presses the button, *K*, current will flow from this battery through both coils on the annunciator, *D*, and in the same direction around the iron core, then through both line wires in parallel and through the key, *K*, to the ground, G^1, returning through the ground, *G*, to the battery. Since the current flows through both coils on *D* in the same direction the iron will be magnetized and the shutter will drop. It makes no special difference if the currents in the two coils are not equal, it is only necessary that the currents in the two coils shall together be strong enough to drop the shutter.

When the drop falls the operator inserts the answering plug in the jack, thereby disconnecting one side of the drop, *D*, from the line circuit and connecting the talking battery, *TB*, through two retarding coils, *I*, *I*, to the two line wires. The listening key, *S*, is arranged so that the operator may listen or talk through either the answering or calling plug, but the ringing key, *W*, as connected here, can only be used to ring out through the calling plug.

When the subscriber is through using the telephone the receiver is hung up and the button, *K*, is pressed, thereby allowing enough current to flow through one coil on the annunciator, *D*, to drop the shutter, thus notifying the operator to remove the cord connections. The shutter is, of course, restored by the operator immediately after receiving the original call and again after receiving the clearing out signal. Only one subscriber's circuit is shown in this figure; the others would all be exactly like the one shown.

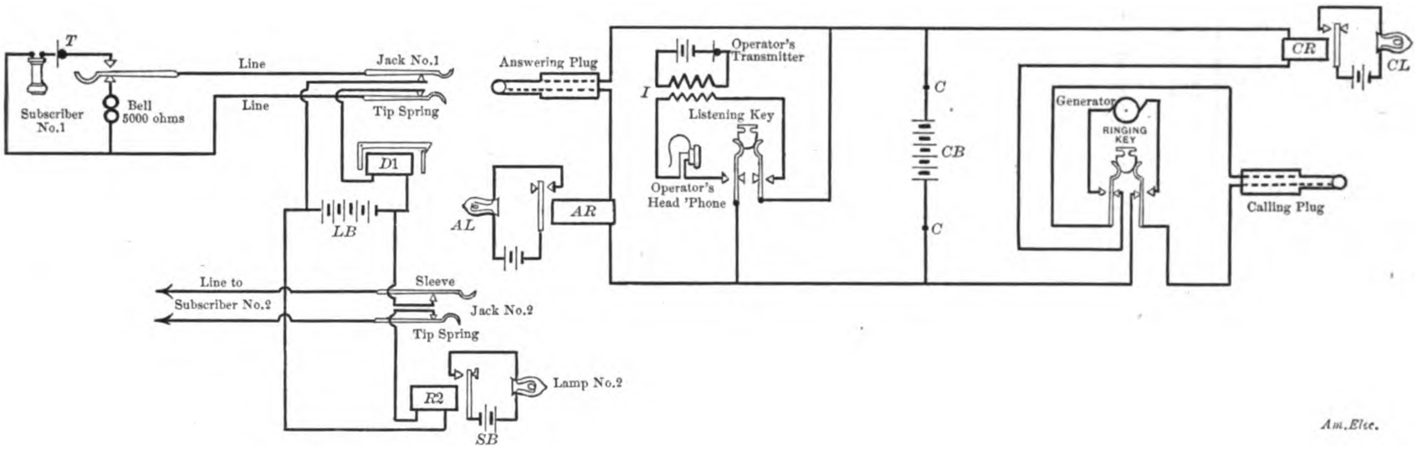


FIG. 15.--COMMON-BATTERY SYSTEM, SHOWING BOTH LAMP AND DROP SIGNALS.

A common battery exchange system is shown in Fig. 15. The bell at the subscriber's station is normally connected directly across the two line wires, but it is cut out and the receiver and transmitter, which are directly in series, are connected in place of the bell when the receiver is removed from the hook. The bell has a very high resistance, at least 2500 ohms, and preferably 5000 ohms. On account of this high resistance enough current cannot flow ordinarily from the battery, *LB*, to affect the annunciator, *D*1. But the receiver and transmitter have a much lower resistance, perhaps 110 ohms, and consequently enough more current can flow from the battery *LB*, through the subscriber's circuit when the receiver is removed from the hook, to drop the shutter of the annunciator, *D*1.

In connection with the No. 2 jack a somewhat different signaling arrangement is shown. A relay, *R*2, is normally connected in the circuit with the battery, *LB*, and the line in place of an annunciator. When the relay is energized it closes a local circuit from the battery, *CB*, through Lamp No. 2, and lights that lamp. The lamp remains lighted until the operator inserts the answering plug in Jack No. 2; this opens the circuit through the relay, *R*2, and hence Lamp No. 2 is extinguished. When the answering plug is inserted in Jack No. 1 current will flow from the common battery, *CB*, through the subscriber's transmitter and receiver, and through the relay, *AR*, which will light the lamp, *AS*. This relay, *AR*, and the relay, *CR*, on the calling side of the cord set are of as low impedance as possible in order not to dampen or distort the talking currents.

The operator's listening set is here arranged in the old way, that is, with the transmitter, a transmitter battery and the primary of the induction coil, *I*, in a local circuit; the receiver and the secondary of the induction coil, *I*, being connected across the cord circuit when the listening key is pressed down. In some switchboards the transmitter and receiver are merely connected across the cord circuit when the listening key is closed, thus making the common battery, *CB*, supply the operator's set with current as well as the subscriber's transmitter. The arrangement shown here seems preferable to the writer, however.

After obtaining from the first subscriber the number of the subscriber with whom connection is desired, the operator inserts the calling plug in the proper jack and then presses the ringing key. This disconnects the calling plug from the remainder of the cord circuit and connects it to the generator, which sends an alternating current only through the calling plug to the called subscriber's line, ringing only the called subscriber's bell. When the called subscriber removes his receiver from the hook, the relay, *CR*, will be energized by current from the common battery, *CB*, and the lamp, *CL*, will light up. When the conversation is finished and the original subscriber hangs up his receiver, the lamp, *AL*, is extinguished; the lamp, *CL*, will go out when the called subscriber hangs up his receiver. Hence, if either subscriber desires to talk to another party, he will not hang up his receiver. The operator, noticing that only one lamp has gone out, will know that only one subscriber has hung up his receiver. She will then close her listening key to inquire what it is that the remaining subscriber wants.

The common battery, *CB*, must have a very low internal resistance if cross-talk is to be avoided. Storage batteries are almost invariably used for this purpose, and cross-talk may be still further eliminated by the use of impedance or retarding coils as in the Stone system, or by the use of repeating coils, as in the Hayes system, at the points, *C*, *C*. The various cord circuits are joined together, preferably at the battery terminals, so as to have as little resistance as possible in that part of the common battery circuit that is common to all cord circuits. This reduces the cross-talk to a minimum.

The talking current in this system must pass through the relays, *AR* and *CR*. This is evidently somewhat of a disadvantage, but it gives the operator such good supervision over the subscribers' circuits that their use is warranted. In fact, annunciators or signals of some kind are absolutely necessary, although, of course, this is not the only possible arrangement. A number of batteries are shown here, and lettered differently for convenience, but in an exchange system one battery, or at most two, would serve for all purposes. Usually a duplicate set of storage batteries would be installed, so that one set could be charging when the other set was in use. Some manufacturers use a common battery of only 12 volts, while some use as high as 50. The Bell companies, and doubtless others, use 24 volts. This seems to be a happy medium, and certainly gives good satisfaction.

THE SPRAGUE MULTIPLE-UNIT SYSTEM.

BY EDWARD CHILTON.

THE PILOT MOTOR CIRCUITS.

In the accompanying diagram it will be noticed that the five-pole switch, *N*, has three sets of wires running to it; one set goes to the master controller, one set to the train line, and the other set to the several parts of the pilot motor circuits. The controller and pilot-motor wires are on one side of the switch and the train line on the other. When the switch is closed, as indicated in the diagram, all three sets of wires are joined together, so that, assuming the pilot-motor circuit to be all right, if the controller shown in the diagram or any other controller on the train (all controllers being in communication with the train line) be closed, the pilot motor will operate to start the car. It can be seen, then, that if the switch, *N*, be opened, thereby separating the train line wires from the rest of the switch, that car will be cut out, as far as the train line is concerned, and while it can still be operated from either of its own controllers, it cannot be operated from the controller on any other car. The switches, *L*, *L*, are mechanically independent of the switch, *N*, so that either can be open while the other is closed.

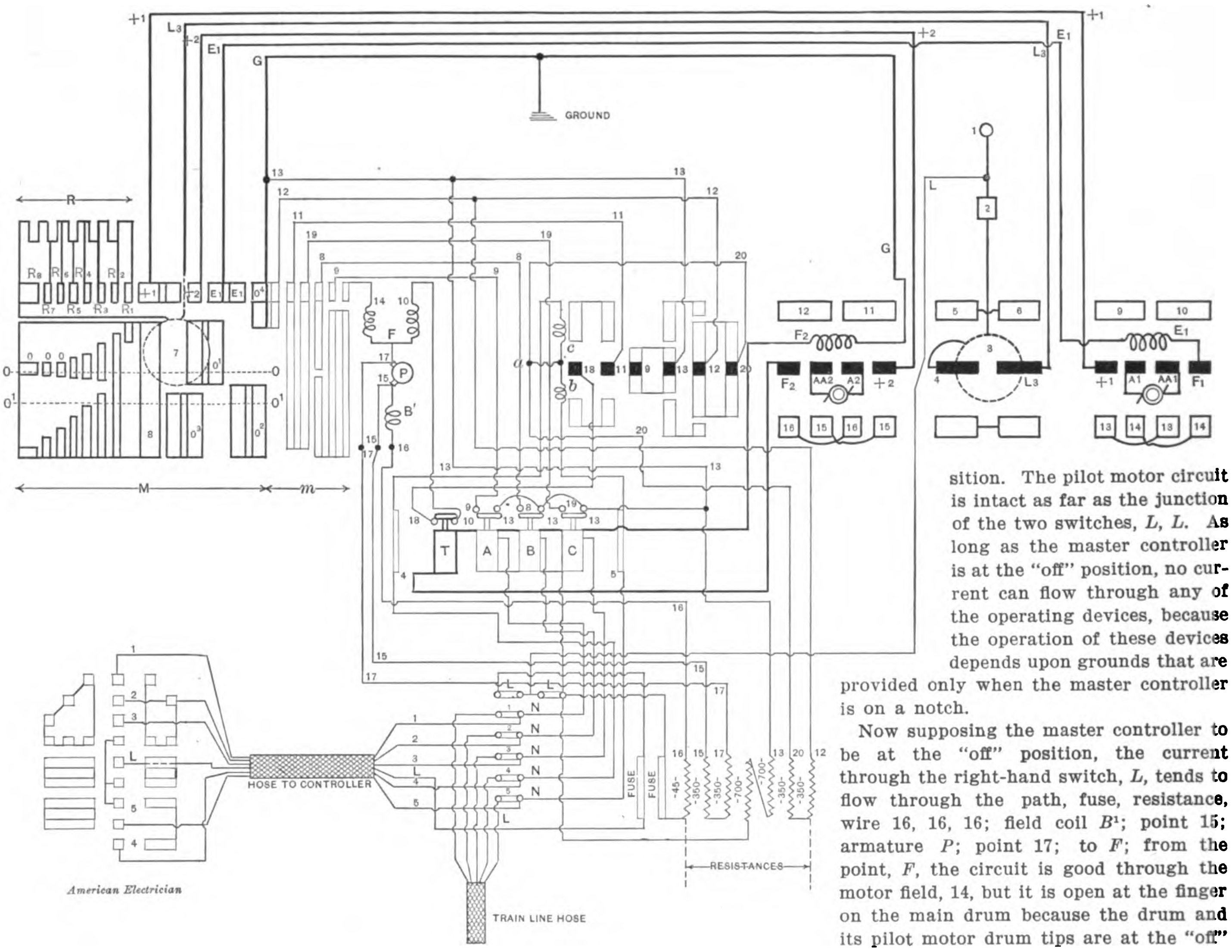


FIG. 1.—DIAGRAM OF CONNECTIONS, SPRAGUE MULTIPLE-UNIT SYSTEM.

When the switches, *L*, *L* and *N*, are all closed the car can be operated from either of its own controllers, or from either of the controllers on any other car in the train, because all controller wires are in communication with the train line wires. If the train line switch, *N*, is open, but trolley switches, *L*, *L*, are closed, that car can still be operated from either of its own controllers, but neither of its controllers can be used to operate any other car in the train, nor can the controller on any other car be used to operate the car whose train line switch is open. If, however, the trolley switches, *L*, *L*, are open and the train line switch, *N*, is closed on any car, the pilot motor and the car motors are dead, so that the car cannot be operated from either of its own controllers nor from the controller on any other car. Although the car motors are inoperative, however, the controllers can still be used to operate the motors on other cars of the train. If the switches, *L*, *L*, and *N* are both open, neither the controllers nor motors on that car are operative, but the fact that the car is dead does not interfere with the operation of cars in front of or behind it, because the train line wires run the full length of the train, and the switch, *N*, when open, simply opens the pilot motor circuits on that particular car.

From the above, it follows that it is a good idea for a motorman to always go through his train before taking it out, to see that all train line and trolley switches are closed; because if either train line or trolley switch on any car is open, that car can do no work and becomes a dead load to be pulled by the motors on the other cars. Assuming the switches, *N* and *L*, *L*, to be closed (also the main motor hood-switch or circuit-breaker, where either is used) the main motor current cannot pass the reverser trolley fingers, as the reverser drum is in its central position. The pilot motor circuit is intact as far as the junction of the two switches, *L*, *L*. As long as the master controller is at the "off" position, no current can flow through any of the operating devices, because the operation of these devices depends upon grounds that are provided only when the master controller is on a notch.

Now supposing the master controller to be at the "off" position, the current through the right-hand switch, *L*, tends to flow through the path, fuse, resistance, wire 16, 16, 16; field coil B^1; point 15; armature *P*; point 17; to *F*; from the point, *F*, the circuit is good through the motor field, 14, but it is open at the finger on the main drum because the drum and its pilot motor drum tips are at the "off" position. The circuit is also good from the point, *F*, through the pilot motor field, 10; contacts, 10 and 18, to finger 18, but stops here, because the reverser drum is at the "off" position. The pilot motor, then, cannot start as long as the master controller is at the "off" position. With the master controller at the "off" position, no current can get through the left-hand switch, *L*; the circuit is good as far as the finger, *L*, on the master controller, but not any further.

The left-hand side of the master controller drum holds the contact tips that are used when the controller is in the "ahead" position; the contact tips on the right correspond to the "back" position of the master controller handle. As soon as the master controller handle is put at the first position "ahead," three pilot motor circuits become alive. The master controller trolley finger, *L*, makes contact with the drum casting immediately opposite it, thereby connecting with the controller finger just under the finger, *L*. This finger being connected to the finger above *L* and also to finger 5 below it, the current coming from the left-hand switch, *L*, to the finger, *L*, divides after it leaves that finger; part of it finds its way to the top finger, 1, by way of the top drum casting and the other part finds its way to the finger below the No. 5 finger, by way of the drum casting immediately opposite the No. 5 finger. The No. 1 finger and the one below No. 5, then, are the fingers through which two of the three circuits referred to above leave the master controller.

On the first notch of the master controller the reverser is pulled out of its neutral or central position to the "ahead" or "back" position, according as the master controller is worked ahead or back. In the present case, we will suppose that the motion of the car is intended to be ahead, so that the master controller is operated on its "ahead" notches. In this case, current from the master controller finger below the No. 5, takes the path, 5 *N* (train switch), fuse 5, reverser coil *b*; point *a*; wire 20, reverser tip 20, reverser tip 12, wires 12, 12, 13, to the ground at *G*. The effect of this current is to pull the reverser drum around so that its fingers, represented by black squares, make contact with the tips below them, at their lowest point. In this position, the fingers, 12 and 20, cease to make contact with the long drum tips under them; finger 20 hangs free from contact with anything, while finger 12 makes contact with the short square tip under it. The result of this change is that the current instead of taking the path which it took when the reverser drum was in its central position, and which it cannot now take because finger 20 hangs in the air, passes from the point, *a*, downward through the wire, 20, the resistance coils marked 350, and thence to the ground, *G*.

The explanation of the change is this: it does not require as much current to hold the reverser drum, once it has been moved, as it does to move it; a large current is more apt to heat the reverser coil than a small one; therefore, as soon as the drum is in its final position 700 ohms of resistance is put in series with the coil to reduce the heating. Another effect, hardly secondary in importance to the heat saving effect is this: When by returning the master controller to the "off" position, the reverser coil, *b*, is left dead, a spring returns the reverser drum to its central position; if the full current of the reverser coil were passing through it, the effect of the so-called "extra current" due to breaking a circuit with a magnet in it would be much greater. Moreover, with the reverser coil working at full strength throughout the range of the return spring (the spring that returns the drum to its central position), it would, perhaps, be impracticable to get as good spring action.

The current from the No. 1 master controller finger takes the path, wire 1; switch, 1*N*; coil *A* (causing the coil to lift its core so that the disc connects the contacts 9 and 13), wires 21, 13, 13, 13 and 13, to *G*, and does nothing more. The third circuit is from the right-hand trolley switch, *L*, through the fuse, 45-ohm resistance; wire 16, 16, 16; coil B^1; brush 15; armature, *P*; brush 17; to *F*. Here the path splits, but the current cannot get through either path, because the left-hand path is open at the drum finger (the controller being still at the off position) and the right-hand path is open at the two relay posts 19 and 8 and cannot close until the discs of the relays are forced up by a current flowing through the relay coils. No current reaches the relay coil, *B*, until the master controller is put on the second position and no current can reach the relay coil, *C*, until the master controller is put on the third position (the second marked notch). All posts and wires marked 13 communicate with the ground, so that in order for any circuit to be complete it must communicate with the ground through some No. 13 connection. On the first position of the master switch, then, the reverser drum is simply thrown "ahead" or "back."

When the master controller handle is moved to the second position (which is the first marked notch on the controller) the No. 1 finger ceases to make contact with the drum casting tip opposite it, thereby interrupting the circuit through the relay, *A*, and causing its core and disc to drop and open the circuit between relay posts 9 and 13. At the same time, however, master controller finger No. 2 makes contact for the first time and establishes the circuit, from the left-hand switch, *L*, through the wire, *L*; finger 2; wire 2; switch point 2*M*, coil *B*, 21, 13, to ground, causing the relay, *B*, to lift its core and disc, establishing connection between relay posts 8 and 13, and providing a path to earth for the current which passes from the right-hand trolley switch, *L*, through the pilot motor. On the first position, no current could get through the pilot motor because one path was broken at finger 14, and the other path was open at relay posts 19 and 8. Then the discs of the relay coils, *B* and *C*, were both down; but now the disc of relay coil, *B*, is up, closing the circuit between posts 8 and 13, so that current from the right-hand trolley switch, *L*, can get through the pilot motor to the ground. The pilot motor starts and runs the controller drum up until the car motors are in full series and all of the starting coil is cut out, then it stops because finger 8, on the pilot motor end of the main drum, runs off the end of the drum tip with which it has been in contact, thereby opening the pilot-motor circuit.

The car will continue to run with the motors in full series as long as the master controller handle is kept on the first notch. Any deviation from this position beyond certain limits, will, however, cause the pilot motor to start again. If the master controller handle be moved to the second marked notch, the pilot motor will start up in the same direction as it was running when it stopped and will move the controller drum up until the motors are in multiple and all of the starting coil is cut out. If, however, the motorman allows the master controller handle to fly around and hit the stop post on the controller top, the pilot motor will start up in the reverse direction and run the main motor controller back to its "off" position. When the master controller handle is put on the third position the second and last marked notch on the controller top, the No. 2 master controller finger ceases to make contact, but the No. 3 finger makes contact for the first time, and through the path, *L*, 3, 3, 3*N*, *C*, 21, 13, 13, 13, 13, *G*, flows a current which lifts the core of relay coil, *C*, thereby causing its disc to close the circuit between relay posts 19 and 13.

As shown in a previous paragraph, as soon as the No. 8 finger of the pilot motor end of the main controller passes off the strip opposite it, the pilot motor circuit is opened, but the disc of relay, *B*, drops down to its open circuit position only when finger 2 fails to make contact because, coil *B* gets its current from finger 2 on the master controller. As soon as finger 8 passes off its drum tip, the circuit through the motor is opened and the disc of the relay, *B*, drops as soon as finger No. 2 ceases to make contact with the drum. Nor can it be raised, except by master controller finger No. 2 making contact to let current into the relay coil, *B*. On the third position, it cannot do this, so that although the finger 8 again makes contact after the break in the tip is passed, its circuit is still opened at the relay, *B*. As soon as relay *C* operates, current from the right-hand trolley switch, *L*, takes the path; fuse, resistance, 16, 16, 16, coil B^1, 15, armature *P*, 17, *F*, 10, 10, 18, 18, 11, 11, 11, 19, 19, 13, 13, 13, 13, *G*. The pilot motor starts and runs the controller drum up to the last multiple notch. Just before the main motor part of the drum reaches the last multiple notch, fingers 11 and 19 run off the drum contact tips, opening the pilot motor circuit again and stopping the motor. As long as the master controller remains on the second notch (third position) current continues to flow through the relay coil by way of the path: *L*, 3, 3, 3*N*, coil *C*, 21, 13, 13, 13, 13, to *G*, and the disc of the relay coil *C* continues to close the circuit between relay posts 19 and 13, but no current flows through the pilot motor and the disc of relay *C* because the circuit of which they are a part is open at fingers 11 and 13.

As stated before, when the master controller handle is turned on, it is turned around against the restraining force of a

THE JOHN CRERAR LIBRARY

spiral spring which, if the motorman releases the handle at any stage of its progress, will promptly return the handle as far as the interference on the controller top. In this position the master controller is in the first position, where finger 1 lets current through relay coil *A*, by way of the path previously traced. The disc of relay *A* is raised, closing the circuit between relay posts 9 and 13. Current from the right-hand trolley switch, *L*, can now pass through the pilot motor, by way of the path: fuse, resistance, 16, 16, 16, B^1, 15, *P*, 17, *F*, 14, 9, 9, 9, 13, 13, 13, 13 to *G*. The pilot motor therefore starts, but since the current now passes through field 14 instead of field 10, as it has in all preceding cases, the polarity of the motor field is reversed, so that the motor runs in such a direction as to run the main controller drum to the off position. Just before the main drum reaches the off position, fingers 14 and 9 cease to make contact with their drum rings, so that the pilot motor circuit is opened and the motor stops. The disc of relay *A* does not, however, drop to the open circuit position unless the master controller handle be moved past the interference lug on the controller top to the "off" position. In such a case, the reverser drum goes back to central position.

BOILER FEEDING STEAM PUMPS.

BY C. W. OBERT.

There are two general classes of steam pumps; single cylinder or simplex pumps, and double cylinder or duplex pumps. The simplex pumps depend for continuous operation upon mechanism arranged to shift the steam valve for reversal of the pump plunger's motion at the end of each completed stroke. In the duplex pumps the valve of each steam cylinder is actuated by a mechanical connection from the piston rod of the other cylinder. It is in the design of these valve gears that the various types of pumps on the market chiefly differ.

A representative type of the simplex pump is that of the Dean Brothers Steam Pump Works (Indianapolis, Ind.), a cross-section of which is shown by Fig. 1. In this pump the valve is controlled primarily by a vertical rocker-arm with a fork at the lower end which engages on a pin attached to the piston rod. This, however, is not alone sufficient to completely reverse the main valve, as the valve would be moved only to the center of its travel and then the whole machine would stop. To overcome this difficulty a small supplemental steam piston, as shown in the upper part of Fig. 1, is provided to move the main steam valve positively past the dead center point, the valve actuated by the rocker arm serving simply to govern this supplemental piston. The length of stroke of the pump is capable of easy adjustment by merely raising or lowering the valve-rod stud in the slot in the upper end of the lever.

The water valves are much simpler in construction and usually require very little care. They consist, as may be seen in the figure, of simple metal or rubber discs held upon their seats by spiral springs; when in operation, the pressure of the water merely forces the disc up from its seat, allowing the water to pass through. The material of which this disc should be made, is, however, a matter of considerable importance. Ordinarily, composition metals, such as phosphor bronze or hard brass, are used for the discs and seats, but if the water contains sand or grit, metal valves do not seat properly, and it becomes necessary to use discs either made of or faced with soft rubber. If hot water is to be pumped, vulcanized rubber discs give the best satisfaction.

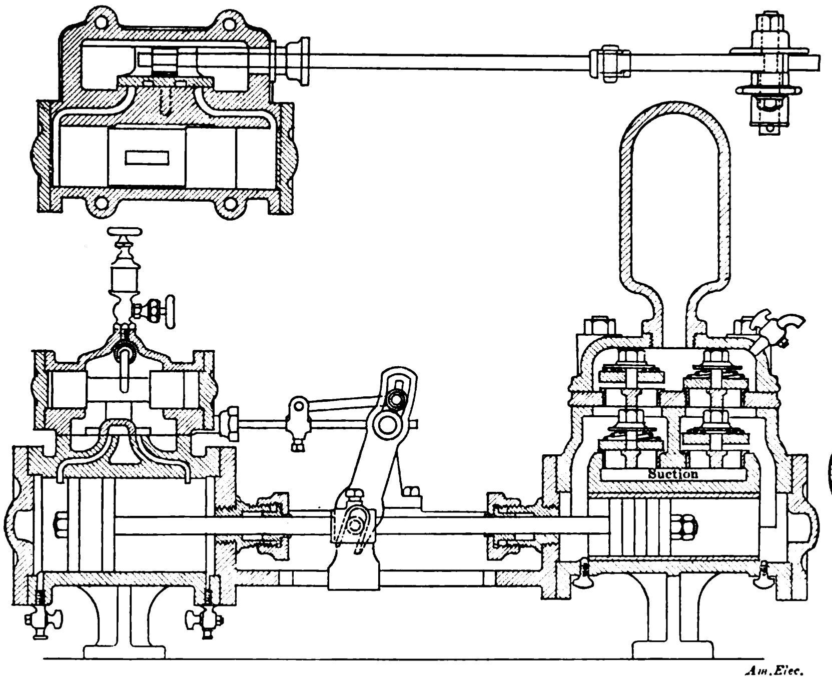


FIG. 1.—DEAN BROTHERS SIMPLEX PUMP.

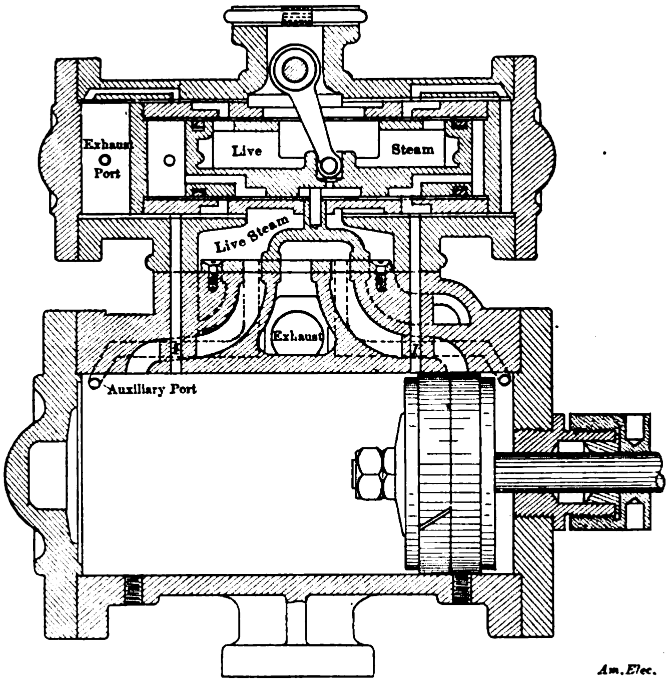


FIG. 3.—BLAKE SIMPLEX PUMP.

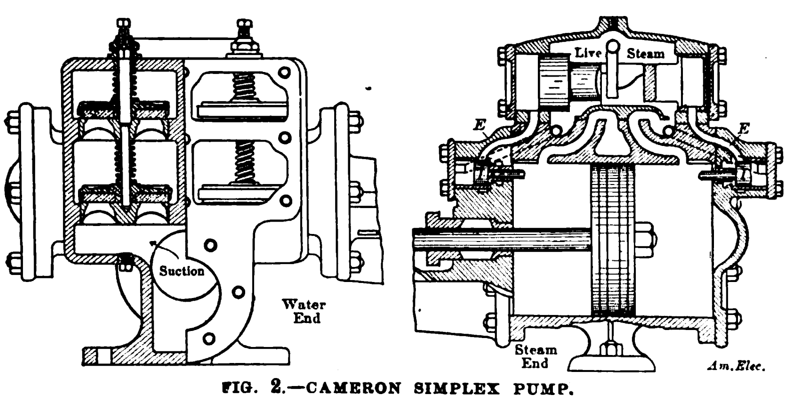


FIG. 2.—CAMERON SIMPLEX PUMP.

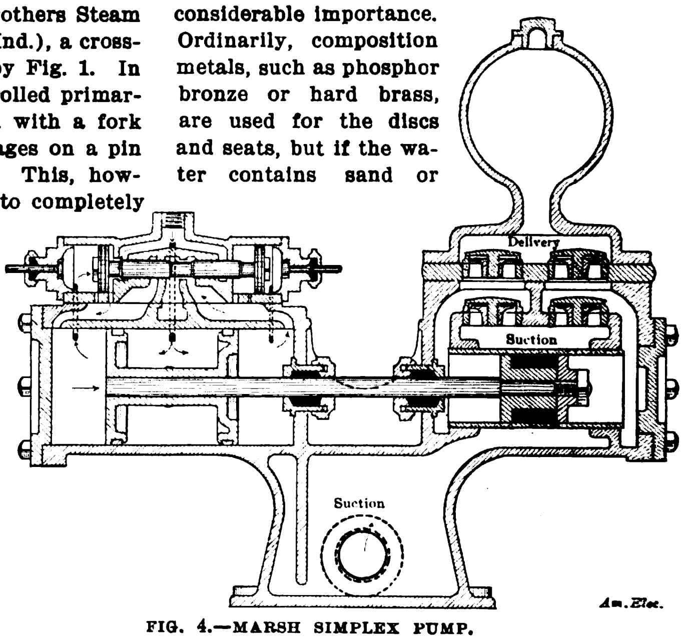


FIG. 4.—MARSH SIMPLEX PUMP.

A very important class of simplex pumps are those that have no outside valve gear, the main valve being actuated by steam. They offer the advantage of simplicity and freedom from mechanism that is exposed to injury. A well-known pump of this class is the one built by the A. S. Cameron Steam Pump Works, New York, and shown in section by Fig. 2. The main valve in this pump is moved, as in the Dean pump, by a supplemental piston, but two tappet exhaust valves, *I*, *I*, one at each end on the inside of the steam cylinder, control the movement of the supplemental piston. The supplemental piston is hollow and filled with steam which, issuing through a hole in each end, fills the spaces between it and the heads of the steam chest in which it works. The pressure being equal at each end, this piston is, under ordinary conditions, balanced and motionless; but when the main piston has traveled far enough to strike and open one of the tappet valves, steam is released from behind that end of the supplemental piston, passing this tappet valve to the main exhaust, and causing a reduction of pressure at that end. Before the pressure can be equalized through the small hole in that end, the steam behind the other end drives the piston over to the other end of its travel, carrying with it the main valve and reversing the travel of the pump piston.

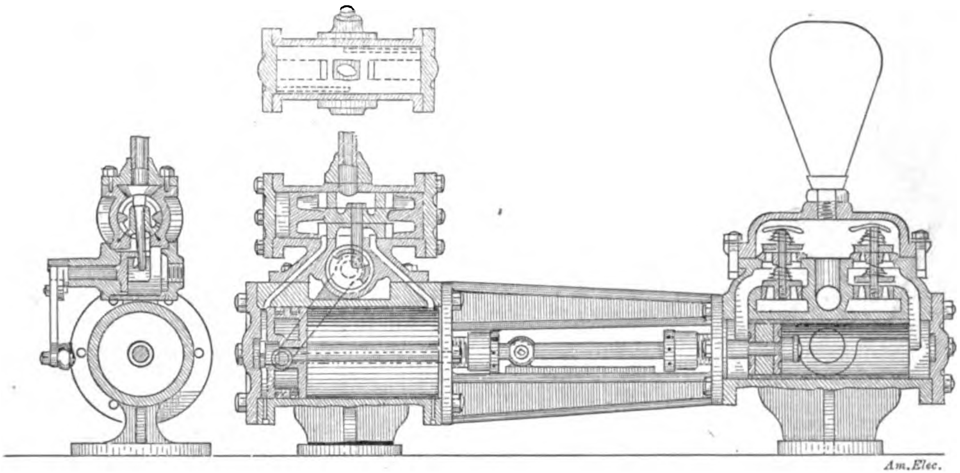


FIG. 5.—DAVIDSON SIMPLEX PUMP.

An important feature of the Cameron pump is the accessibility of the water valves for inspection and repair. By merely removing a cover plate the four valves are exposed, two being situated on each deck, as illustrated. The valve seats are simply forced into tapering holes in the decks and may thus be easily removed for renewal, while each valve stem holds two valves with their springs one above the other, so that by removing a stem both valves are released.

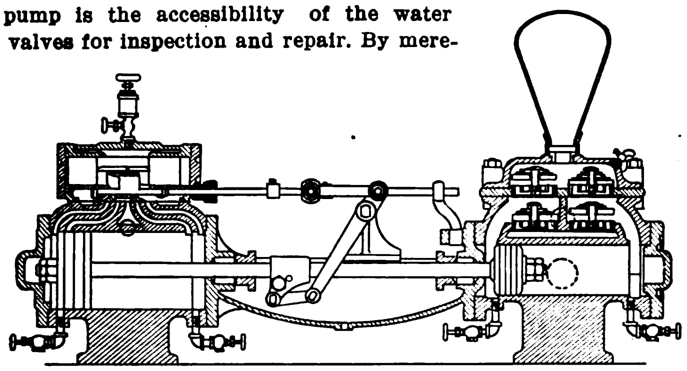


FIG. 6.—DEANE SIMPLEX PUMP.

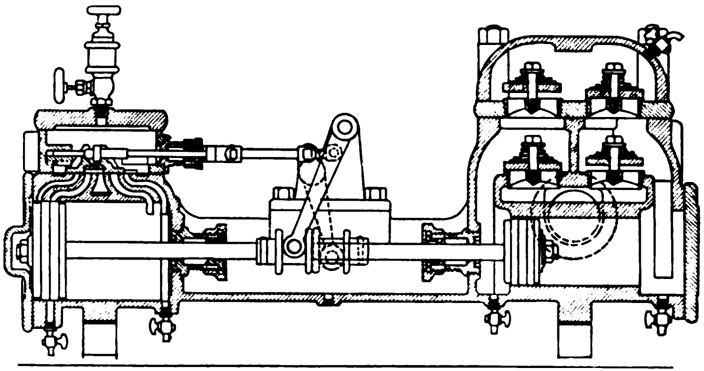


FIG. 7.—DEANE DUPLEX PUMP.

Another pump of this class is that of the W. H. Blake Steam Pump Company, Fitchburg, Mass., shown in section by Fig. 3. In this pump the main valve is governed by two reciprocating supplemental pistons, one within the other, working in the steam chest. As the main pump piston reaches the end of its stroke, it uncovers a small port, *I*, allowing steam to pass from its live steam side to the corresponding end of the inner supplemental piston, which is thereby forced in the opposite direction. This movement allows live steam to pass to the same corresponding outside end of the outer supplemental piston, which forces it in the opposite direction also, thereby reversing the main slide valve and thus reversing the pump.

In Fig. 4 is shown still another pump of this class, built by the American Steam Pump Company, Battle Creek, Mich., and known as the Marsh pump. The main valve of this pump is also moved by a supplemental piston, but the main piston here serves as the valve for the supplemental piston. The main piston differs from the ordinary solid piston in that it is of spool form with packing rings on each head; the interior space thus provided is always filled with live steam from a connection to the steam chest. When the main piston arrives at the end of its stroke the head nearest the cylinder head passes and uncovers a small port in the side of the cylinder, which allows the live steam from the interior of the piston to pass up to the outside of that end of the supplemental piston and force the supplemental piston to the other end of its travel and reverse the travel of the pump piston. The water valves in this pump are devoid of springs, seating themselves by gravity. Central stationary deflecting discs are provided which prevent the valves from performing the duty of deflecting the water and consequently rising too high.

Fig. 5 represents a simplex pump that has only one valve, namely the Davidson. The illustration shows transverse and longitudinal sections of the pump. The valve is actuated by a direct mechanical connection to the main piston rod, but the mechanism is so arranged that the valve is nearly motionless during the greater part of the stroke, with a rapid motion of reversal, accelerated and insured by the piston action of the valve itself. This valve has both a longitudinal and an oscillating motion, the valve being of the piston type. Fastened to the valve, and projecting down into the exhaust cavity beneath, is a key that engages in a cam in the exhaust chamber, which cam is rocked back and forth by a connecting rod pivoted to the main piston rod. As the main piston nears the end of its stroke, the cam suddenly twists the valve and opens a port which allows steam to pass to the outside of the piston head at that end of the steam chest, forcing the valve to the end of its travel and preventing the possibility of stalling that the cam might allow if it were depended upon alone. The water valves of this pump are of the disc type, seated by spiral springs, and they are easily accessible. The removal of one valve stem liberates two valves for inspection or repairs.

The Deane Steam Pump Company, of Holyoke, also builds a simplex steam pump, a sectional view of which is shown in Fig. 6. The valve gear of this pump, which slightly resembles the valve gear shown in Fig. 1, consists of a main valve moved by a supplemental piston and a supplemental valve controlling this piston. The supplemental valve is actuated intermittently by a rocker-arm which is connected to and reciprocated by the main piston rod, so that at the end of each stroke it admits steam to the proper end of the supplemental piston to cause it to reverse the motion of the pump. If, however, the supplemental piston fails accidentally to start promptly under the influence of steam pressure alone, a lug on the valve rod engages with it and compels its motion by power derived from the piston rod, thus insuring certainty of action in any case.

The other great class of steam pumps is the double cylinder, or duplex type. The duplex pump is simply two steam pumps side by side, the slide valve of each receiving its motion from the piston of the other. In fact, it is nothing more or less than an adaptation of the simplex pump with the supplemental piston, in which the supplemental piston is enlarged and made to do the duty of driving an extra pump plunger, the valve functions remaining identically the same.

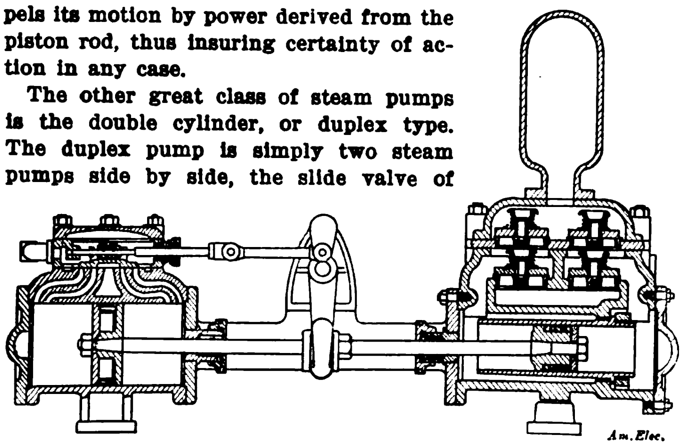


FIG. 8.—WORTHINGTON DUPLEX PUMP.

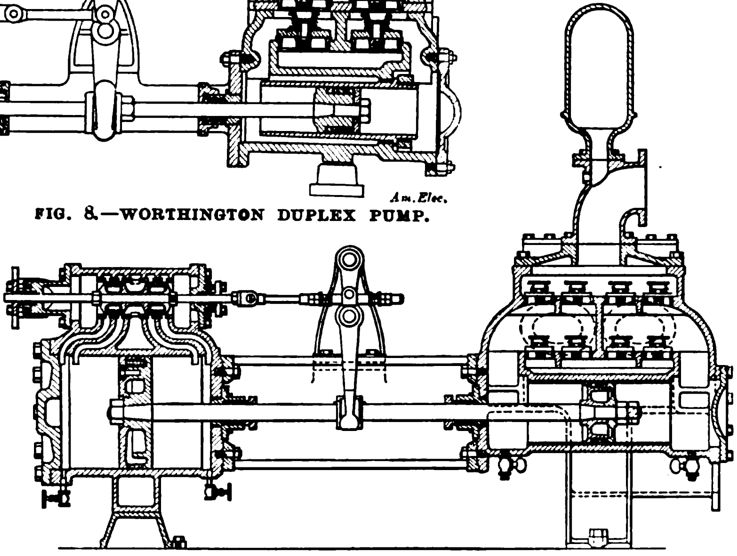


FIG. 9.—EPPING-CARPENTER DUPLEX PUMP.

Fig. 7 represents the duplex pump of the Deane Steam Pump Company. The valves of this pump are of the plain D type, with a double-ported valve seat, as shown. The double ports perform the function of entrapping a portion of the exhaust steam and utilizing it in the end of the cylinder to cushion the pump piston at the end of the stroke. The slide valve of the cylinder shown in the engraving is actuated by a rocker arm which engages with the piston rod of the cylinder not shown, as indicated by the dotted lines, while the slide valve of the cylinder not shown is actuated by the rocker-arm shown in front and engaging with the piston rod of the illustrated cylinder. The operation of the duplex pump is simple; as one piston is completing its stroke, the rocker-arm engaging on its rod opens the valve of the other cylinder for it to begin a stroke, and while the other cylinder is making its stroke the first cylinder remains idle until the other rocker-arm traverses its valve, when it makes another stroke. In this way one piston is always in motion, and at the end and beginning of each stroke, where the motion of both pistons is the slowest, both are moving. The water valves in both the simplex and duplex Holyoke Deane pumps are of the disc type, held upon their seats by conical spiral springs.

One of the best known of the duplex pumps is that built by the Henry R. Worthington Hydraulic Works, New York, one style of which is shown by Fig. 8. The slide valves of this pump are also of the D pattern, and the valve of each cylinder is actuated by the piston rod of the other cylinder. In fact, the operation of this pump is exactly the same as that of the Deane duplex pump just described, a double-ported valve seat being also used for cushioning the piston at the end of the stroke. The water end of the pump illustrated is of the inside plunger type, a plunger working in a packed bushing or sleeve being used instead of the ordinary piston. The bushing is grooved annularly for water packing. This plunger is located some inches above the suction valves, thus forming a subsiding chamber below, into which any foreign substance may fall. The water valves are of the disc pattern, held upon their seats by spiral springs, and are accessible through hand-holes.

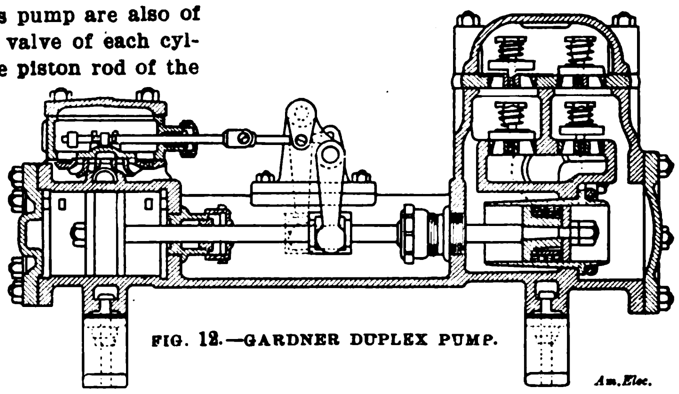


FIG. 12.—GARDNER DUPLEX PUMP.

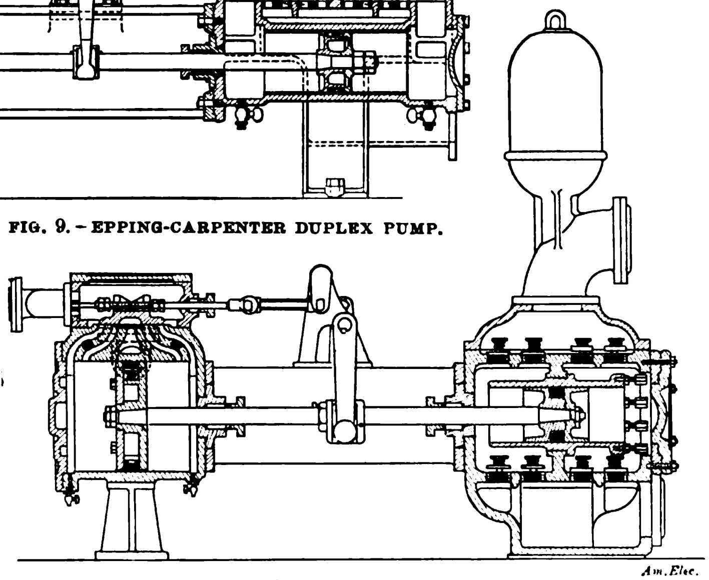


FIG. 10.—SMITH-VAILE DUPLEX PUMP.

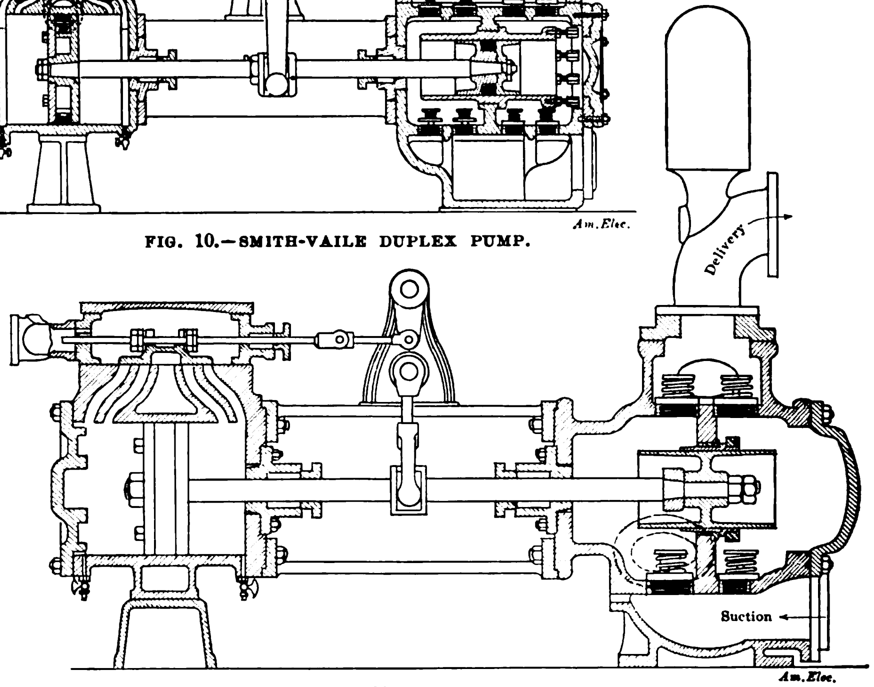


FIG. 11.—DEAN BROTHERS DUPLEX PUMP.

The Epping-Carpenter duplex steam pump, shown in Fig. 9, has balanced piston valves, instead of D valves; the usual double-ported seat for cushioning the piston with exhaust steam is employed, and the valve rods are equipped with external "lost motion" adjustments for convenience in valve setting. The water valves are of the conventional disc type, held upon seats by spiral springs, and are accessible through hand holes.

Among the other important duplex pumps on the market are the Smith-Vaile pump, built by the Stilwell-Bierce & Smith-Vaile Company, Dayton, Ohio, and shown by Fig. 10; the Dean Bros. (Indianapolis) pump, shown by Fig. 11, and the Gardner pump, built by the Gardner Governor Company, Quincy, Ill., and shown by Fig. 12. They all have plain D valves, and the valve seats are all double ported for piston cushioning with exhaust steam. A feature of all three of these pumps is an easily removable cylinder bushing in which the water piston works. This construction obviously facilitates replacing or reboring a bushing without disturbing the general structure of the pump. The water valves of all three pumps are of the regular disc pattern, held upon the seats by spiral springs. The operation of these pumps is identical with that of the duplex pumps previously described.

It should be added that a feature of all plunger-type pumps is that the bushing or ring in which the plunger works is readily removable for reboring, and that practically all makers build both the plunger and piston types. Most makers also build the water end with all the valves above the cylinder or with the suction valves below, as preferred. Both forms have their advantages. With the suction valves above the cylinder the piston or plunger is always flooded and there is less danger of "losing the suction." With the suction valves below the cylinder the head or lift is slightly reduced, the course of the water through the pump is much more direct and the valves are more accessible than in the other construction.

COMPARATIVE TESTING OF FAN MOTORS.

BY S. D. GILBERT.

In the fan-motor season of the year an important question to central stations supplying current for such motors on "flat" rates is: Which of the numerous fan motors will circulate the most air with the least consumption of energy? The Electric Lighting Company of Mobile has met this question by making simple but careful comparative tests with the aid of the apparatus represented in the accompanying diagram. Here, *A* and *B* are kite-like screens, supported upon the ends of a large bell-crank lever pivoted on a knife edge at *C*; *W* is a counter-weight and *D* is a scale which measures the pressure in ounces on the screen. The horizontal screen, *A*, is used for ceiling fans and the vertical screen, *B*, for those of the desk type. The distance from each of the screens to the center of the fan blades is 12 ins. when the pointer of the scale is at zero.

A formula deduced from the theoretical rate at which a fan gives kinetic energy to the air makes the efficiency of the fan directly proportional to the 1.5 power of the pressure on the screen. This formula, however, contains constants which it is almost impossible to determine positively, so that its application is not practicable. And although theory seems to indicate that the 1.5 power of the pressure on the screen is the criterion of the output of the fan, the writer considers that for all practical purposes it is sufficient to consider the efficiency of the fan as being proportional to the pressure on the screen instead of the 1.5 power of that pressure.

While efficiency is a very important point, and one which cannot be overlooked in the selection of fans, there are other factors which are not to be entirely sacrificed for it. For instance, a certain make of fan might, after being comparatively tested, show an efficiency far ahead of any other, but after examining their different mechanisms we find that the motor which shows the highest comparative efficiency shows also inferior mechanical construction which would doubtless, after a short run, bring its efficiency far below any of those with which it was formerly compared. After a more careful examination we might contribute this to faulty bearings which cause the armature shaft to wear, thus causing more friction, or poor oiling devices, or excessive rise in temperature which might char the insulation and cause short circuits, or faulty brush holders, which would cause the brushes to make uneven contact, consequently wearing ridges in the commutator, or again its construction might be such that repairing would be difficult. These and various other details, which alone would not condemn it, but taken collectively, could not, for the sake of efficiency, be overlooked.

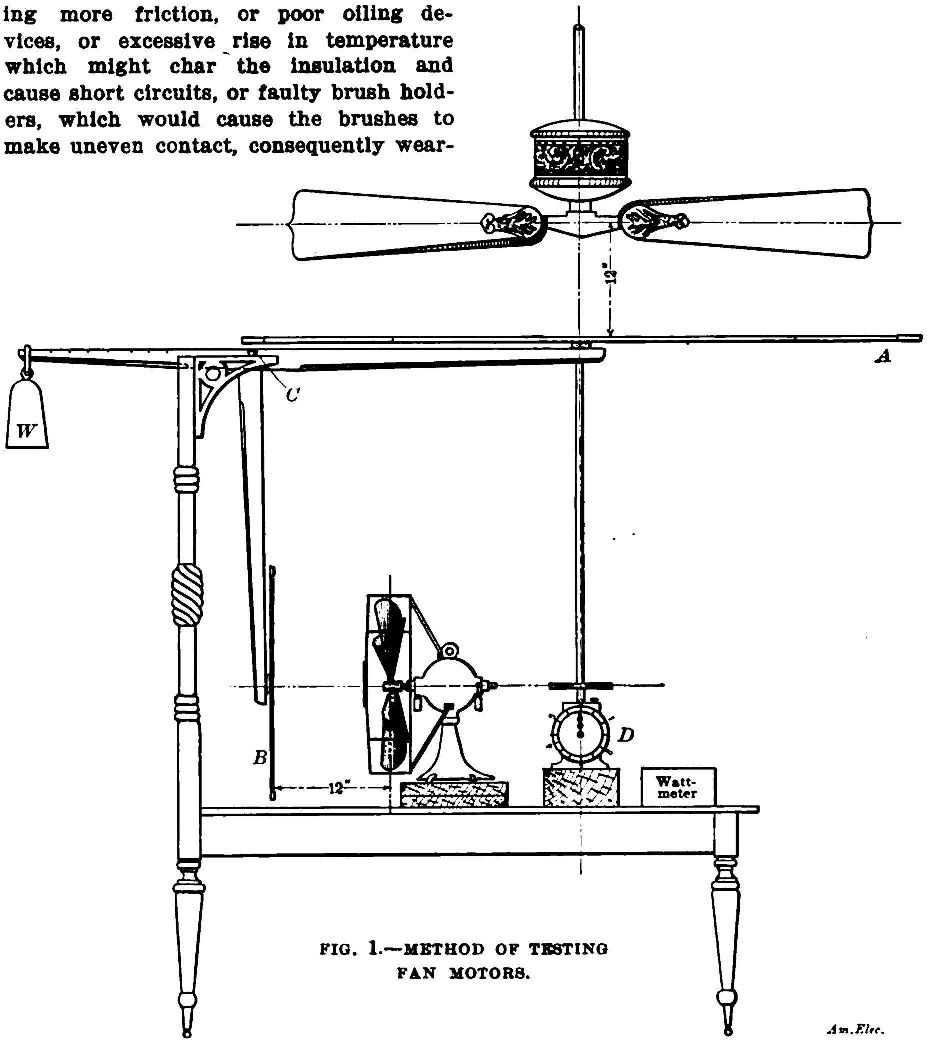


FIG. 1.—METHOD OF TESTING FAN MOTORS.

Lessons in Practical Electricity

THE STATOR OF AN INDUCTION MOTOR.

The stationary part, or stator, of an induction motor combines the functions of a field magnet with those of an armature.

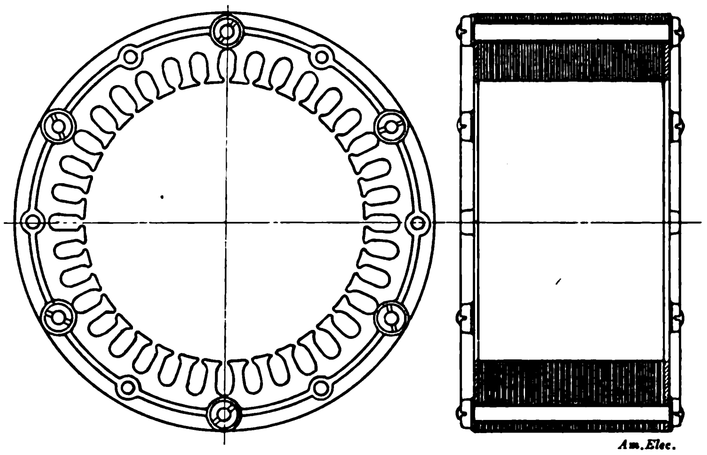


FIG. 20.—STATOR CORE OF AN INDUCTION MOTOR.—FIG. 21.

As its windings and the current in them produce the magnetic flux which causes the rotor to revolve, it is a field magnet, but in all other respects it behaves precisely as though it were a stationary armature within which a field magnet is being revolved. On this account, instead of being provided with physical poles of the ordinary type the core is made exactly as that of an external armature would be made, except that the slots are larger, as illustrated by Fig. 20. The core is laminated, as the sectional view, Fig. 21, indicates, for precisely the same reasons that armature and transformer cores are laminated.

There are several other reasons why the form universally employed for the stator is preferable to the more familiar type of field magnet with projecting poles; it will perhaps suffice to give one. The windings of the rotor and those of the stator must approach as nearly as possible the conditions of the primary and secondary windings of a transformer, because their inductive relations are the same—the flux induced by the primary (stator) winding must be enclosed by the loops of the secondary (rotor) conductors to the greatest possible extent in order to give the machine good efficiency and a reasonable power factor. If the two sets of conductors could be wound in the same slots it would be infinitely preferable, but as one set moves and the other doesn't, this is manifestly impossible.

In order to simplify the explanation of the combined effect of two sets of field windings supplied with two currents differing in phase, the stator of an elementary induction motor was described in the April Lesson as having the coils mounted as indicated in Fig. 2, which is repeated here for convenient reference. In practice, even if bipolar motors were used, the coils would not be thus mounted. Referring to Fig. 1, also repeated here, it will be evident that the coils, *A* and *B*, can be maintained in their present positions in the stator core by simply parting the end portions and bending them around against the ends of the core, as indicated in Fig. 22, and this is what would be done in an actual machine.

As the rotating magnetic field sweeps around it is "cut" by the wires in the stator slots precisely as the wires of an alternator armature cut the lines of force of the magnetic field, and an e.m.f. is induced in each winding, *A* and *B*, equal to

$$4.44\ \Phi\ n\ N \div 100{,}000{,}000 \quad \ldots\ldots\ldots (7)$$

in which Φ is the number of lines in the rotating magnetic field n is the frequency of the magnetic current, and consequently the number of revolutions per second of the magnetic field (in a bipolar motor); and N is the number of complete turns in each coil. This is precisely analagous to the action of a direct-current dynamo, in which the e.m.f. generated in the armature winding is equal to $\Phi\ n\ w \div 100{,}000{,}000$. Most of the apparent discrepancy between this formula and formula (7) is due to the facts that here w, representing the wires on the armature, is used instead of N, the number of turns, and that the wires are not all in series on the armature, whereas they are so on the stator. If we consider the turns, N', on a drum armature instead of the wires, the formula becomes

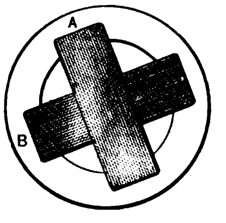


FIG. 1.

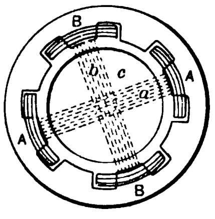


FIG. 2.

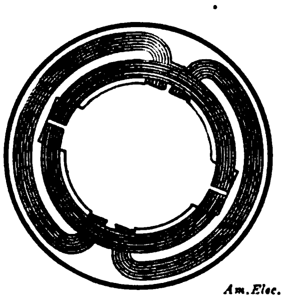


FIG. 22.—BIPOLAR STATOR.

$$E = 2\ \Phi\ n\ N' \div 100{,}000{,}000;$$

and if we only consider those turns, N, that are in series with each other, it becomes

$$E = 4\ \Phi\ n\ N \div 100{,}000{,}000.$$

The only difference between this and formula (7) is that the constant is 4 instead of 4.44; the reason for this is that in the direct-current armature the wires do not all cut the flux at the same rate, whereas the wires on the stator are not so distributed and consequently the difference in their rates of cutting is much less and the total e.m.f. considerably higher. When the stator winding is more distributed, as the multiplicity of slots in Fig. 20 truthfully indicates that it is in practice, the e.m.f. induced in the winding by the rotating flux is less than formula (7) makes it, the correction usually being made by retaining the constant 4.44, which is fundamental, and introducing another constant representing what is usually termed the coil-breadth factor. In most two-phase motors this second constant is between 0.91 and 0.92, which is equivalent to reducing the constant 4.44 (which is a shortening of the more accurate figure, 4.442853) to 4, making the alternating-current formula agree with that for a direct-current armature.

The e.m.f. thus induced in the stator windings opposes the e.m.f. which is applied to the stator terminals, and furnishes the counter e.m.f. of the machine. As the flux remains constant it would seem that the counter e.m.f. would be constant, which would not be logical. The reaction of the rotor upon the field, however, causes the counter e.m.f. to vary with the load; this will be explained later.

Letters on Practical Subjects

Another "Mysterious Current."

To the Editor, American Electrician;

Sir:—The note in the March number on "A Mysterious Current," recalled to the writer a peculiar experience that he had some time ago. A 30-kw. inductor alternator was giving considerable trouble from the heating of the bearings; nothing could be done to keep it cool, the very best oil of different kinds being used. The writer tried several different kinds of bearings in the machine, but still could not improve the running qualities, the machine running from a week to a month and then getting so hot as to necessitate shutting down. Finally a test was made for stray currents from one bearing to the other, and the result was a little surprising, as the inclosed diagram will show. The machine was running at a speed of 1550 r.p.m. and the primary voltage was 1050 volts, with an output of 18 amperes.

It was found that between the two opposite bearings on the shaft there was a difference of e.m.f. of 0.029 volt, as indicated on the diagram. Several other readings were taken on the machine which are interesting and instructive. As shown in the diagram there is a difference of pressure between the journal and the bearing at the pulley edge ranging from 0.014 to 0.04 volt. This variation was undoubtedly due to the oil insulating the parts more or less perfectly. The greatest difference of pressure, viz.: 0.2 volt, was between the pulley and the outer edge of rotor. The trouble with the bearings was undoubtedly caused by these currents flowing from one journal to the other, as the resistance between bearings was extremely low whenever the shaft was in contact with both journals. The low e.m.f. developed was sufficient to cause a large flow of current, roughening the

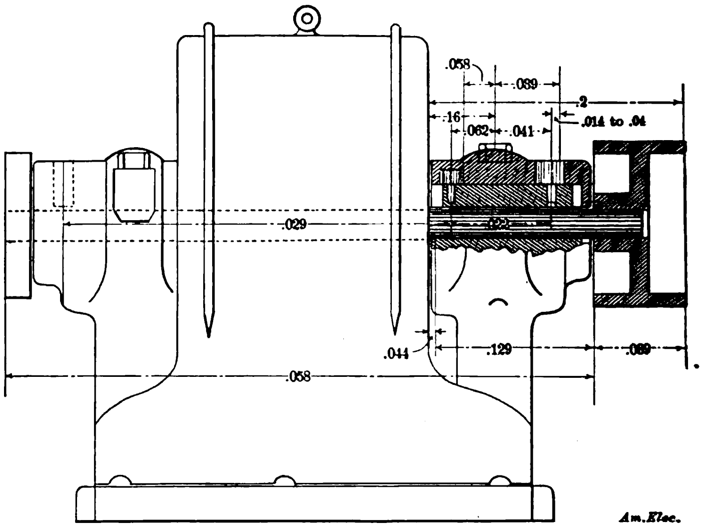


DIAGRAM SHOWING STRAY DIFFERENCES OF POTENTIAL.

parts in contact, and causing them to gradually become hotter and hotter as the machine continued to run.

The trouble was entirely eliminated by reducing the outer diameter of the boxes slightly, and insulating them from the machine with a single turn of writing paper. This was about two years ago, and no trouble whatsoever has been experienced with the bearings since then.

F. O. Broill.

San Francisco, Cal.

◆

A Problem in Connections.

To the Editor, American Electrician;

Sir:—Referring to the problem in connections submitted by Mr. George Moutonnet in your May issue, I desire to offer the solution shown by the enclosed diagram, in which *C* and *D* are two-way knife switches. When the handle of *C* is swung upward, the first requirement, that of lighting the lamp, *A*, can be fulfilled by swinging the handle of *D* upward also. Now leaving *D* in this position, we may either extinguish the lamp, *A*, or light both *A* and *B*, or light *A* alone, by properly manipulating the handle of the switch, *C*. Mr. Moutonnet's next specification is that with both lamps lighted by means of the switch, *C*, they may be extinguished by the switch, *D*. This is obviously done by breaking connections at *D*, after which the whole cycle of operations may be repeated. I think this will be seen to answer all his requirements.

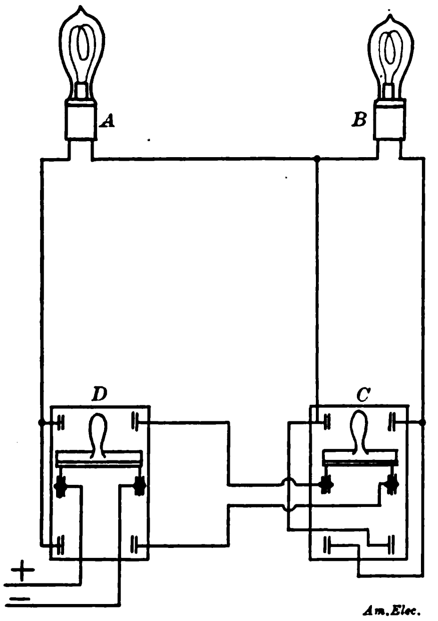


FIG. 2.

Easton, Pa. B. G. Eckard.

◆

To the Editor, American Electrician;

Sir:—The problem in connections for which a solution was asked by Mr. George Moutonnet in your May issue, may be solved, as indicated in the accompanying diagram, by the use of double-throw knife-blade switches. It is impossible to fulfill the conditions specified by the use of snap switches. The problem was to make the connections so that the lamp, *A*, can be lighted by means of the switch, *D*; then cut out by the switch, *C*. The next requirement is that the switch, *C*, shall either relight the lamp, *A*, alone, or both of the lamps, *A* and *B*; next, with both of these lamps lighted, presumably by means of the switch, *C*, they must be turned out by the switch, *D*, and the series of operations just described carried through again. Referring to the diagram, it will be evident that with the switch, *D*, thrown downward, for example, the lamp, *A*, may be lighted alone by throwing the handle of the switch, *C*, downward, the left-hand blade of the switch, *C*, being disconnected from the circuit. The lamp, *A*, may then be extinguished by opening the switch, *D*, and may also, of course, be relighted by reclosing the switch, *D*, in the downward position. Both of the lamps may be relighted by throwing the switch, *D*, to the upper position, in which position the left-hand blade of the switch, *C*, becomes alive and connects one side of the circuit to both of the lamps. From this point on the series of operations can be repeated as often as desired. With the switch, *D*, in either position, throwing the switch blade, *C*, in the same pos'tion will light the lamp, *A*; and throwing it in the opposite position will light both of the lamps, which is the fundamental requirement of the problem.

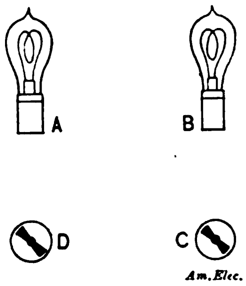


FIG. 1.—ORIGINAL DIAGRAM.

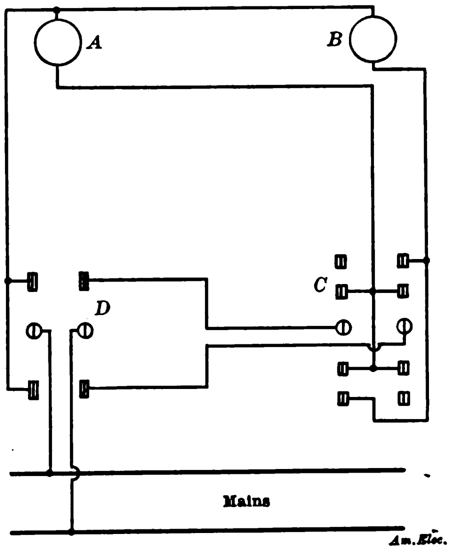


FIG. 3.

George W. Malcolm.

Brooklyn, N. Y.

◆

To the Editor, American Electrician;

Sir:—I submit herewith a solution of Mr. Moutonnet's problem which appeared in the May number of this paper. The switches required are somewhat elaborate for the purpose, a triple-pole double-throw switch being used at *C* and a double-throw switch at *D*. The lamps are to be connected to the circuit in multiple, as usual. A much simpler arrangement could be made if they were to operate in series, but this arrangement is not considered because it is not conventional.

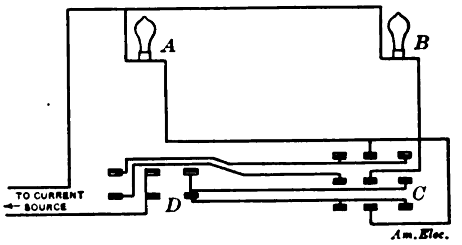


FIG. 4.

At the beginning of the series of operations the switch, *D*, is assumed to be open and the switch, *C*, closed to the right. Closing the switch, *D*, to the left lights the lamp, *A*; opening the switch, *C*, extinguishes the lamp, *A*, and closing the switch, *C*, to the left lights both of the lamps. Then opening the switch, *D*, extinguishes both lamps. To repeat the series of operations the switch, *D*, is then closed to the right, when the lamp, *A*, will burn. Opening the switch, *C*, will extinguish this lamp, and closing the switch, *C*, to the right will light both of the lamps; then opening the switch, *D*, cuts out both lamps, and so on indefinitely. Besides the conditions of Mr. Moutonnet's problem, it is evident that either switch will light or extinguish the lamp, *A*, or both of the lamps when the other switch is closed in either position.

Chas. J. Sutter.

St. Louis, Mo.

◆

To the Editor, American Electrician;

Sir:—The enclosed is a solution of Mr. George Moutonnet's problem in connections published in your May issue. To start, assume that *C* is closed upward. To light the lamp, *A*, close the switch, *D*, upward. Open the switch, *C*, and the lamp, *A*, goes out. Close switch *C* downward, and both lamps will light. Open switch *D*, and both lamps will go out. Then close *D* downward, and *A* will light. The operation may be gone through any number of times.

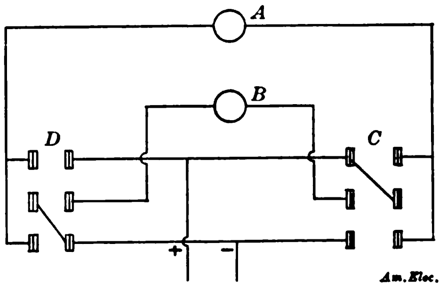


FIG. 5.

Albert J. Levine.

New York, N. Y.

◆

To the Editor, American Electrician;

Sir:—The enclosed diagram is my solution of the problem in connections submitted by Mr. Geo. Moutonnet in the May number of your paper. The switches in the diagram are four-point snap switches but four-point knife switches may be substituted. It will be evident that the left-hand switch at either station *C* or station *D* will always control the lamp, *A*, independently of the other switches, and the right-hand switch of either pair will similarly control the lamp, *B*, so that either of the two lamps or both of them may be lighted and extinguished at will from either *C* or *D*. The continuation of the main line wires beyond the points, *E* and *F*, is merely done for the sake of completeness. L. D. S. Gaster.

New Orleans, La.

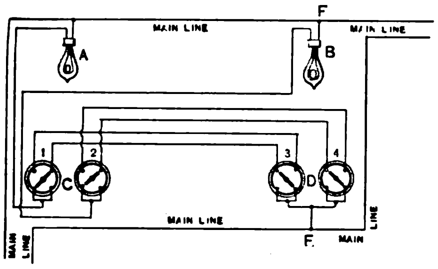


FIG. 6.

◆

To the Editor, American Electrician;

Sir:—I submit herewith a diagram as a solution of the problem in connections by Geo. Moutonnet which was published in your May issue. The diagram is practically self-explanatory. The points, *m* and *m*, represent the terminals of the system of wiring or the connections to the main line wires. The switch, *D*, is an ordinary single-pole snap switch, and *C* is a three-point single-pole switch of any convenient construction having one wire attached to the center of the blade. An ordinary three-point switch could easily be adapted to the requirements of the problem.

Hanover, N. H. F. E. Austin.

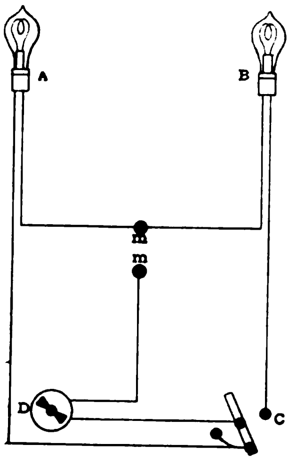


FIG. 7.

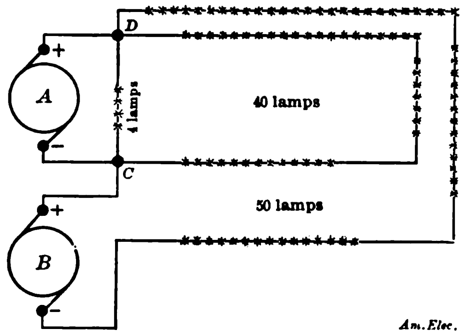
[All of the foregoing solutions fulfil the conditions of Mr. Moutonnet's problem with the exception of Fig. 7, which fails because the switch at *D* simply has the function of closing and opening the circuit. The solution of Fig. 2, however, is scarcely a proper one, because it requires the operation of the two lamps in series, which is not the normal method of connection for incandescent lamps. The relative merits of the other four solutions will be obvious to the reader.—Editor.]

An Arc-Lighting Problem.

To the Editor, American Electrician;

Sir:—Referring to the arc-lighting problem of Mr. Swalm in your May issue, 10 amperes would flow from dynamo, *A*, through the 50 lamps, through dynamo *B* and back to *A*. There would be no current in either the four lamps or the 40 lamps. Dynamo *B* would regulate for a 50-lamp load, and dynamo *A* would not do any work. Albert J. Levine.

New York, N. Y.



ARC LIGHTING PROBLEM.

◆

To the Editor, American Electrician;

Sir:—In reference to F. M. Swalm's arc-lamp problem published in your May number, I think that if the current in both dynamos is kept constant at 10 amperes (and if it is not, the data given are entirely insufficient) the 50 lamps will remain burning normally while the 4 lamps and the 40 lamps will go out. Each machine will generate a voltage sufficient to overcome its interior resistance and the machine, *B*, will generate in addition to this the necessary voltage for the 50 lamps. The result seems rather curious, but it is what Kirchoff's law gives if the current in both dynamos is maintained at 10 amperes. Joel Gomborow.

Philadelphia, Pa.

A Chemical Rectifier.

To the Editor, American Electrician;

Sir:—Having never seen in your columns a description of a chemical rectifier I submit the accompanying sketches and description of an apparatus which I have made for personal use in connection with the 200-watt transformer described in the American Electrician for July, 1900, thinking it may be of interest to your readers. The transformer was wound to reduce 110 volts to 15. With this voltage I am able to charge four storage batteries of five amperes capacity. Fig. 1 is a diagram of the arrangement. The chemical rectifier is made as follows: A strip of aluminum is bent into an arc conforming approximately to the curvature of a two-quart jar; this strip should have an area of at least 15 square inches in the solution. The other terminal consists of a sheet of lead corrugated so as to give as large a surface as possible, and bent into an arc similar to the shape of the aluminum strip. The zig-zag curved line in the sketch indicates the lead electrode, and the plain curve the aluminum. The lead sheet should have about 24 sq. ins. of surface area. The solution consists of two quarts of water, in which are dissolved two tablespoonfuls of soda and three tablespoonfuls of alum. The current delivered to the storage batteries is, of course, unidirectional and pulsating, as the rectifier suppresses one-half of the current wave, leaving the other to fluctuate from zero to maximum. By using three rectifiers and putting two 50-volt 25-c.p. lamps in series with the circuit, connecting the lamps in parallel with each other, I was enabled to charge the batteries direct from a 52-volt alternating-current supply circuit. Fig. 2 shows the connections of this arrangement.

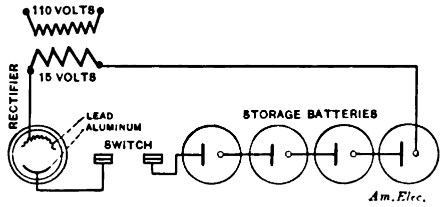


FIG. 1.—CHEMICAL RECTIFIER.

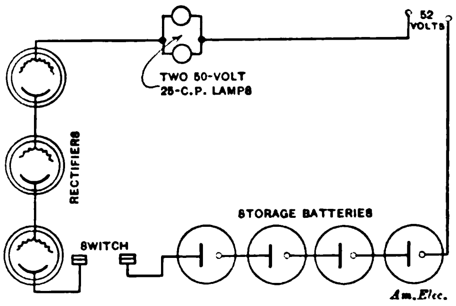


FIG. 2.—CHEMICAL RECTIFER.

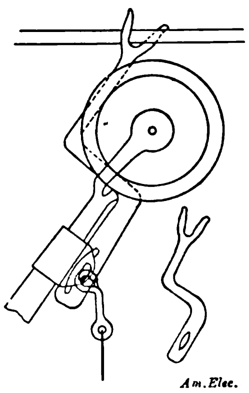
Revere, Mass. C. Hazen Farnham.

◆

A Handy Sleet Cutter.

To the Editor, American Electrician;

Sir:—Referring to the article on sleet cutters published in your February issue, I would say that I have used a cutter or scraper which did the work and did not require much juggling or changing of trolley wheels, and although one is not likely to use a srcaper this summer, still I think there may be some of your readers who will be interested in a description of ours.



SLEET CUTTER.

The scraper is simply a piece of iron, wrought into shape by our blacksmith. The accompanying sketch shows its construction. The shape of the scraper permits it to be dropped into place in the fork where it serves to conduct the current and also to hold the wheel away from the wire. The slot in the lower end of the scraper fits over the eye of the rope-swivel or collar on the pole, and the rope snap holds the scraper in place. We have used these scrapers several years, and never had any trouble.

Such a scraper can be put on or taken off in much less than 30 seconds, which fact counts, when a man is running on a short schedule and where the headway is too great to prevent sleeting of wire by the plain wheel; another advantage being that the only tools needed are a pair of hands.

A. A. Deighton.

Philadelphia, Pa.

Electrical Catechism

605. *How many arc lamps are in use?*

Probably one million arc lamps are in use in various parts of the world. Within three years of its commercial introduction in 1895, enclosed arc lamps had come into use to the extent of about 150,000, and their use is rapidly increasing the total number of arcs in use.

606. *What is meant by a 2,000 candle-power arc light?*

A so-called 2000-c.p. arc light is one that absorbs about 459 watts. It gives about 800 to 1400 candle-power in the direction of greatest intensity. To avoid false impressions it is customary to speak of such a light as of "2000 nominal candle-power."

607. *What is meant by a 1,200 candle-power arc light?*

Such a light absorbs about 300 watts, or 6.8 amperes at about 45 volts. The actual light is equal to that of about 600 candles in the direction of its greatest intensity.

608. *What are the temperatures in the arc?*

There is some variation in the results of different investigations, but the temperature of the crater at the end of the positive carbon is between 6232 and 7052° Fahrenheit. The temperature of the end of the negative carbon is about 4532°, while the temperature of the arc itself is reported as 7052 to 8672°. The arc has about the highest temperature obtainable.

609. *Is any use, other than lighting, made of the high temperature of the arc?*

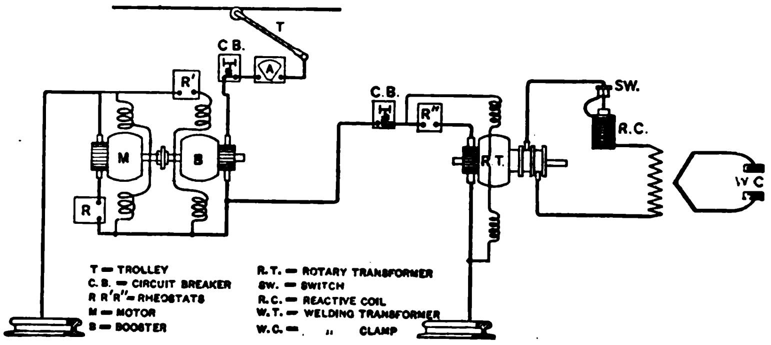
Various processes for welding metals and for the reduction of metals or other metallurgical work have been developed both from the heat of the arc and also from the heat from the ordinary operation of the current. These are sometimes classified as incandescent and arc processes.

610. *What different processes are there for electric welding?*

There are three classes of processes; that of Thomson, who sends a heavy current through the two pieces whose ends are placed in close contact and are pressed together when the current has heated their ends to a welding temperature; a second class is that developed by Barnardos and others, who use the arc to heat the metals to the desired temperature; a third method is developed from the "water pail forge" of Lagrange and Hoho.

611. *Describe the Thomson welding process.*

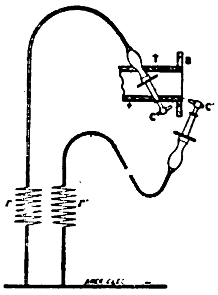
Thomson's welding process consists in passing an electric current of great volume, by means of two clamps of good conducting metal (generally copper) through two pieces firmly abutted against each other between the clamps, which, when heated by the current, are forced together by mechanical pressure. The metal between the clamps alone possesses sufficient resistance for the conversion of considerable electrical energy into heat. The only considerable loss of energy is that caused by conduction of heat to the clamps of the apparatus, by radiation, and the resistance loss in the electrical generator and the welding machine. There are three parts to the apparatus: a generator of alternating currents; a welding transformer for changing the small current at high pressure to a large current at low pressure, this being provided with clamps and mechanical appliances to work the heated metal; and an electrical regulating apparatus to control the flow of current. The current required for working copper approximates 60,000 amperes per square inch of metal. Welds have been made as large as 48 sq. ins. in a single weld. One of the most interesting processes is the welding of rails on street railways.



ELECTRIC RAIL WELDING.

612. *How are rails electrically welded?*

One car carries a rotary transformer which changes a current of about 275 amperes at about 500 volts from the trolley line into an alternating current of 300 volts. The alternating current passes to the welding transformer, which is hung on a crane behind the car. The rails to be welded are butted against each other and two chucks are welded from either side to the ends of the two rails. A hydraulic jack forces the chucks against the cleaned ends of the rails and so completes the weld after the current has supplied the necessary heat. About four welds can be prepared and finished in an hour.



BARNARDOS ARC WELDING PROCESS.

613. *Is the heating effect of the current used for metal working other than welding?*

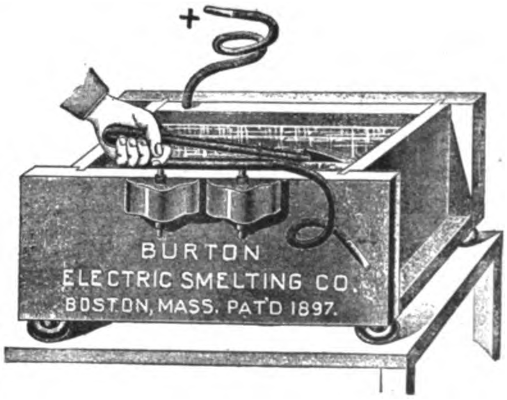
Thomson has used heavy currents for heating and annealing spots in steel armor plates where it is desired to drill holes or to do other work. A similar process has been worked out commercially by Burton, who heats metals by current from a transformer and then forges it by various machines into any shape desired. He has also developed forges based on the Hoho effect, in which a liquid forms part of the circuit; this is known as the "water-pail forge."

614. *Describe the water pail forge.*

Lagrange and Hoho found that if an electric circuit was closed by dipping the negative terminal into a conducting liquid, the cathode or negative terminal became very hot and melted if the voltage was above 125. This has been developed by Burton and others into what is known as "hydroelectric heating." The best solution is ten parts of carbonate of soda and one part of borax dissolved in water until the specific gravity is 1.15 at 70° Fahrenheit. Metals can be heated for welding, or the heat may be graduated for such purposes as heating soldering irons.

615. *What is an electric furnace?*

An electric furnace is an arrangement for obtaining a high temperature in an enclosed space by means of the heat from an electric current passing through a comparatively high resistance. The furnace is generally lined with carbon or some other refractory material that can stand the high temperature. The current generally enters and leaves through plates or rods of carbon.


+
BURTON
ELECTRIC SMELTING CO.
BOSTON, MASS. PAT'D 1897.

WATER PAIL FORGE.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

Why does iron become crystallized? (2). Can it be restored to its original state by annealing? T. A. J.

Crystallization is usually caused by repeated mechanical shocks. (2). No.

If the U tube shown by Fig. 1 is filled with water the level will be the same in both legs, of course; if the funnel leg of the other tube (Fig. 2) be filled with water, will the water have the same level in both legs? R. C. G.

Certainly.

Is the current in the secondary of an induction coil that has an interrupter alternating? (2). Does the transmitter of a telephone break the circuit like the interrupter of an induction coil? (3). What is the longest spark ever given by an induction coil? W. H. A.

Yes. (2). No; it merely varies the resistance of its circuit. (3). We do not know.

Can an electromagnet be built with 50 sq. ins. of pole surface to lift 3000 lbs.? (2). If so, will the magnet attract this weight to a distance of 6 ins.? (3). Can the attraction of an electromagnet be changed to repulsion by reversing the current through the coil? W. F. S.

Yes. (2). It is possible, but such a magnet would be enormously heavy and consume a tremendous amount of energy. (3). No.

Why would not an induction coil be more satisfactory if made with a short thick core instead of a long one of comparatively small diameter? E. R.

Because when the necessary amount of wire would be wound in the secondary coil the outer layers would be so far from the core that there would be excessive leakage of magnetic flux within the coil. In other words, the efficiency of the outer windings would be greatly reduced.

Why are the lines of a three-phase system transposed at short distances? (2). Are telephone lines mounted on the same poles transposed for the same purpose? O. T. S.

In order that the mutual induction between the three wires will average up exactly alike for each wire over the length of the circuit. (2). No; telephone wires are transposed in order to neutralize the inductive effect of the heavy currents in the power line.

How much bluestone is required for an ordinary crow's-foot battery in a jar 6 x 8 ins.? (2). How often should the battery solution be replenished? S. A. G.

About 2½ lbs. will usually be sufficient. (2). When the blue tinge in the solution rises to within ½ in. of the zinc, part of the solution should be drawn off and fresh water put in. The need for fresh bluestone is indicated plainly by the condition of the crystals already in the jar.

Why does inductance tend to neutralize capacity in an alternating-current line? T. F. R.

Capacity in a line causes the current wave to lead the e.m.f. wave, and the difference of phase between the two causes a reduction of the power factor. Inductance in a line causes the current to lag behind the e.m.f., and this difference also reduces the power factor. If the capacity and inductance are properly proportioned the leading tendency of the current is exactly offset by the lagging tendency, so that the current remains in phase with the e.m.f. and the power factor is maximum.

How is the current of a three-phase alternator figured when there is only one ammeter? (2). Is the current capacity of the machine stated as the sum of the current in the three wires or the current in a single wire? B. H. W.

When only one ammeter is used it is assumed that the three phases are balanced. Then the combined effect of the three currents in the three wires is equivalent to the current indicated by the ammeter multiplied by 1.732. (2). The capacity of an alternator is usually stated as the current per phase.

What is considered to be the limit of distance from the station to the center of distribution for a 200-volt direct-current system? R. C.

There is no hard and fast limit of distance. The distance to which service can be delivered depends roughly upon the cost of producing a kilowatt-hour at the switchboard and the rate charged for the service per kilowatt-hour at the point of delivery. The cost per kilowatt-hour at the switchboard must include all of the operating expenses of the plant. The limiting distance would be that which would make the interest on the cost of the line and the expense of maintaining it equal the profit from the service.

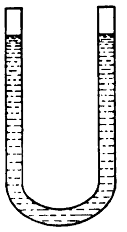


FIG. 1.

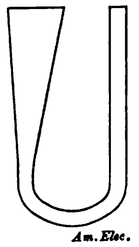


FIG. 2.

Please give directions for an induction coil and condenser to give a ⅝-in. spark. A. W. L.

Make the core of a bundle of No. 22 wires ½-in. in diameter and 5 ins. long. Make the primary winding three layers of No. 16 wire and the secondary winding of 10 ozs. of No. 36 silk-covered wire. Wind the coils to a length of 4½ ins. Make the condenser of tinfoil sheets, 4 x 5 ins., separated by thin tough linen paper sheets, 5 x 6 ins. Use 40 tinfoil sheets.

A single-phase 52-volt alternating-current fan motor will not start when current is applied, but if started by hand runs up to speed and continues running. If it is not started by hand the field coils heat excessively; please explain this. H. F. H.

The motor is evidently not provided with shading coils, and a single-phase induction motor thus built will not be self-starting. When the armature is at rest it forms a closed secondary for the field coils and the effect is the same in kind as that in a transformer when the secondary winding is short-circuited; the current is excessive and the windings overheat.

Do the lines of force which pass from a pole piece to a toothed armature core pass entirely through the teeth or do some of the lines pass through the slots? (2). What is meant by "tooth leakage" in an armature? J. P. W.

Most of the lines of force pass through the teeth but a small proportion passes through the slots themselves. In machines which have oversaturated armature teeth a considerable proportion of the lines of force pass down through the slots. (2). What is usually meant by tooth leakage is the leakage of lines of force from corner to corner of adjacent T-shaped teeth, but it has never been established that such leakage actually occurs to an appreciable extent.

Can the humming of a telephone line suspended from the roof of a house to a pole 300 ft. distant be prevented when a strong wind is blowing? (2). Is the drop in voltage over an alternating-current circuit the same as over a direct-current circuit carrying the same load? M. P. B.

The humming can be greatly reduced and probably suppressed entirely by the use of a small device known as the "anti-hum," which can be procured from any dealer in electrical supplies. (2). Not unless the wires are very close to each other, as, for example, when the two wires are enclosed in the tubing of a conduit system. If the circuit wires are an appreciable distance apart, such as 6 ins. or more, the alternating-current drop will be greater than the direct-current drop.

What is the tensile strength of ordinary commercial copper wire? (2). What is the strain on a span of No. 4 copper wire 100 ft. long with a dip of 2 ft.? G. R. G.

The tensile strength of soft copper wire varies between 32,000 and 36,000 lbs. per square inch of cross-section; that of hard copper wire varies between 45,000 and 68,000 lbs. per square inch. The averages usually employed in computations are 34,000 lbs. for soft wire and 60,000 lbs. for hard wire, except for very large sizes when the tensile strength is taken as being somewhat less than this. (2). If the wire is insulated the strain at the center of the span will be about 100 lbs.; if it is bare the strain will be about 80 lbs.

How should the field winding of an alternator be changed to suit a change in the armature winding from 1000 to 2000 volts? (2). What is the ratio between the voltage at the terminals of a field winding and the voltage at the brushes of an alternator? (3). How can I cut out a damaged armature coil on a street railway motor which has an odd number of coils? L. M. K.

No change in the field connections will be necessary; if there are series coils these must be changed to suit the armature change. (2). There is no particular ratio between the two voltages; the usual voltage employed for exciting the fields of alternators is 125 volts. This is used merely because a 125-volt dynamo is a standard machine, and an ordinary incandescent lighting dynamo may be used as an exciter. (3). Cut off the terminals of the coil within an inch of the end of the armature core and tape them thoroughly. Then join together the ends of the two short pieces of wire which remain connected to the commutator segments; solder the joint and tape it thoroughly.

GOULD RAILWAY CAR LIGHTING SYSTEM.

One of the few electrical systems for railway car lighting that have progressed to the stage of manufacture and operation is that of the Gould Coupler Company, Depew, N. Y., the features of which are illustrated herewith.

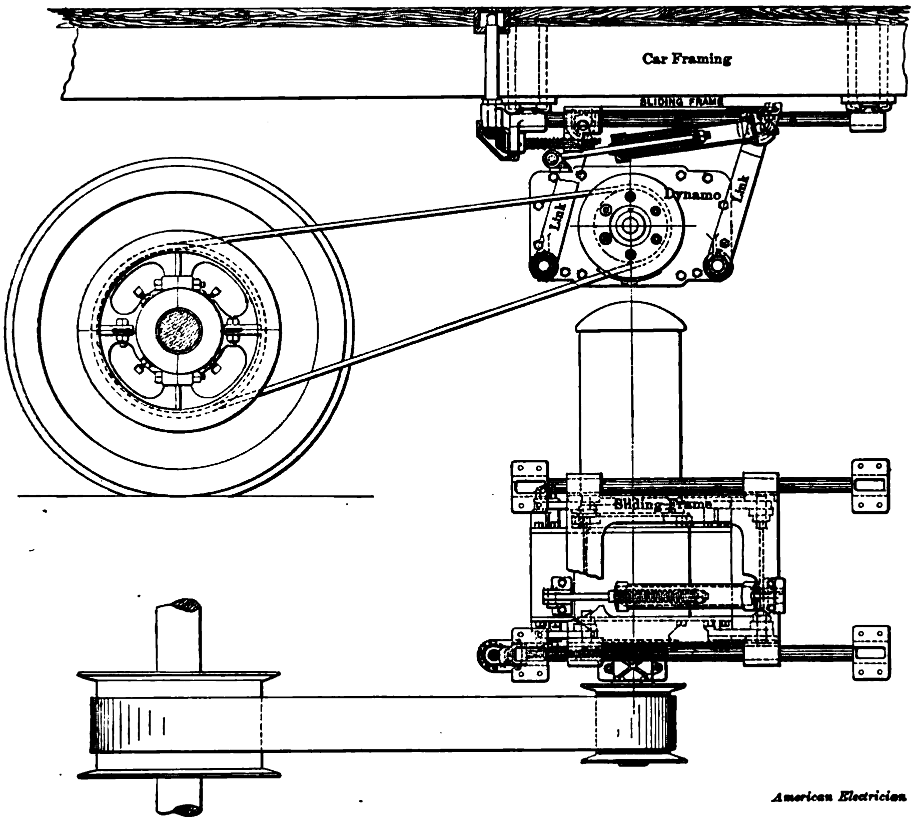


FIG. 1.—DYNAMO SUSPENSION IN GOULD CAR LIGHTING SYSTEM.

The fundamentals of the system are a dynamo hung under the car and belt-driven from the axle, two batteries of storage cells to take care of the load at low car-speeds and standstill, and an ingenious arrangement of switches which automatically cut the dynamo into circuit as soon as its e.m.f. equals that of the circuit, cut it out when the e.m.f. falls below that point, and reverse the dynamo field connection when the direction of car travel reverses. Figs. 1 and 2 illustrate the dynamo suspension. Reference to Fig. 1 will show that the dynamo is pivotally hung on four links, the upper ends of which are pivoted to a framework or carriage arranged to slide on two round rods forming ways. A heavy helical compression spring is hung at one end to the frame of the dynamo and at the other to the slidable framework or carriage. Its force tends to swing the dynamo on its links away from the pulley on the car axle, thus maintaining the belt tight. The force of the spring is adjusted by setting the slidable carriage, which is accomplished through the medium of a screw and bevel gears, as plainly shown in Fig. 1. The short piece of vertical shaft carrying the horizontal bevel wheel stops just below the floor level of the car, and its upper end is machined to fit a ratchet wrench which is used to adjust the mechanism just described. Referring to Fig. 2 it will be seen that the belt and pulleys are entirely enclosed by a casing or shield which is provided with a flexible or so-called telescoping joint of the bellows variety. The construction and its purpose will be entirely obvious upon an inspection of the engravings.

A sectional view of the dynamo is given by Fig. 3. The machine is of the multipolar enclosed type, having two salient and two consequent poles. The armature is barrel-wound and carries on one end of its shaft a centrifugal governor which closes and opens a switch connecting the machine to the lighting circuit. When the speed is such that the e.m.f. is sufficiently high, the governor closes the switch. This switch is a composite affair of peculiar construction. The part moved by the governor consists of a set of blades mounted on an insulating arm and a lug adapted to close two rocking switches. These switches are mounted on a small stationary switchboard on the dynamo, which also carries several sets of jaws into which the blades moved by the governor fit. This will be made clearer by reference to Fig. 4, which is a diagram of the system. With the dynamo shaft revolving in the direction indicated by the arrow, the blades (not shown) controlled by the governor are twisted into alignment with the three pairs of jaws marked "Armature Brush," "Field Brush" and "Armature Brush," respectively; the lug, which is integral with the arm carrying the blades (see Fig. 3), is in alignment with the left-hand ends of the rocking switches shown at the top of the switchboard.

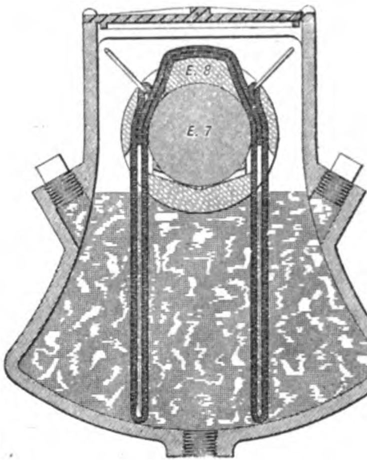


FIG. 5.—METHOD OF LUBRICATION.

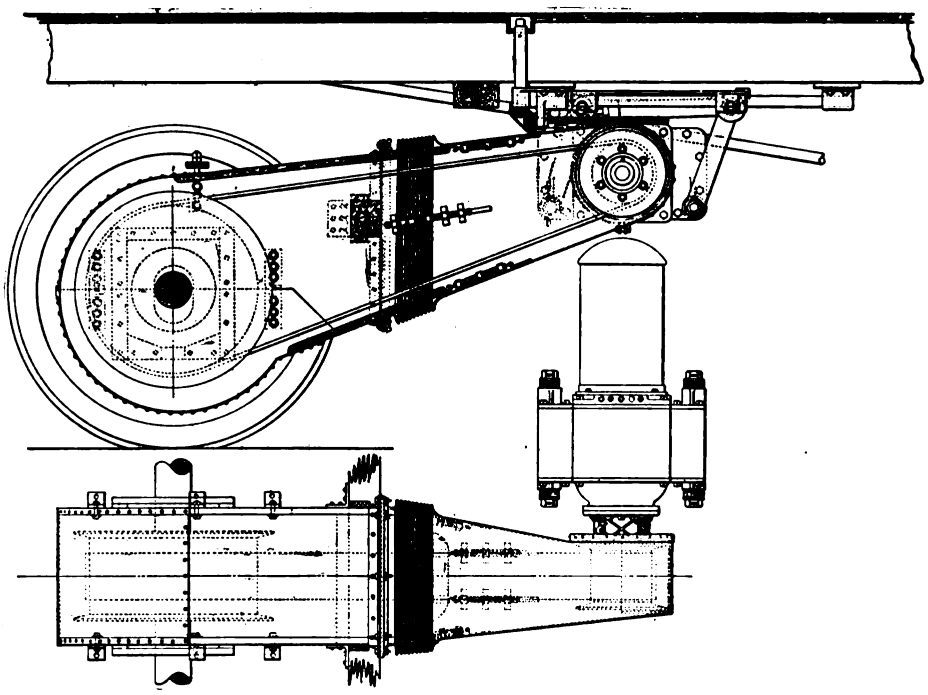


FIG. 2.—SHIELD FOR BELT AND PULLEYS OF CAR LIGHTING DYNAMO.

This twisting into position is effected, of course, before the governor speed is high enough to put the blades into the jaws. With reversed rotation, the blades would be twisted into alignment with the three unlabeled sets of jaws and the lug into alignment with the right-hand ends of the rocking switches. Tracing the connections will show that this will reverse the polarity relation between the dynamo and the storage batteries.

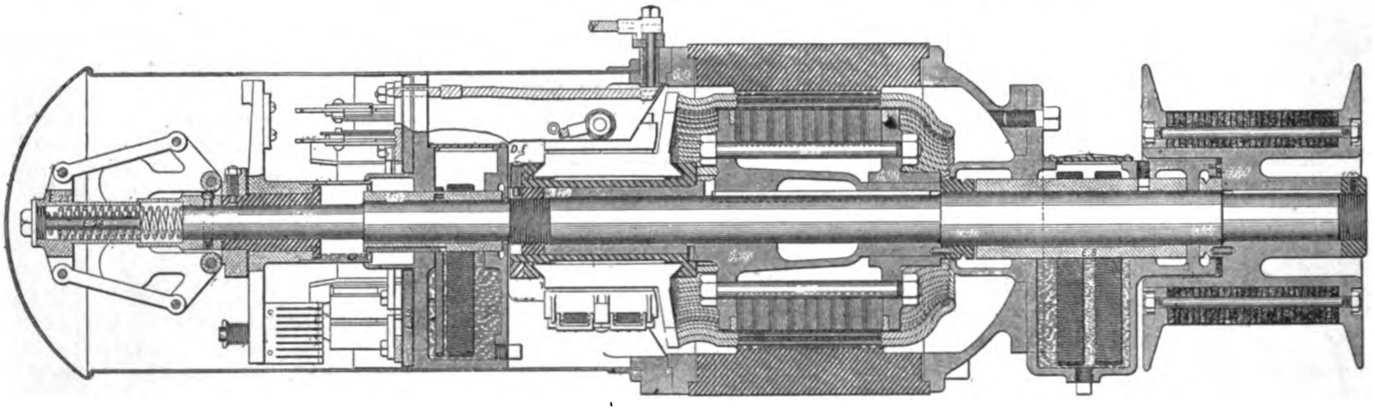


FIG. 3.—SECTIONAL VIEW OF DYNAMO AND PULLEY.

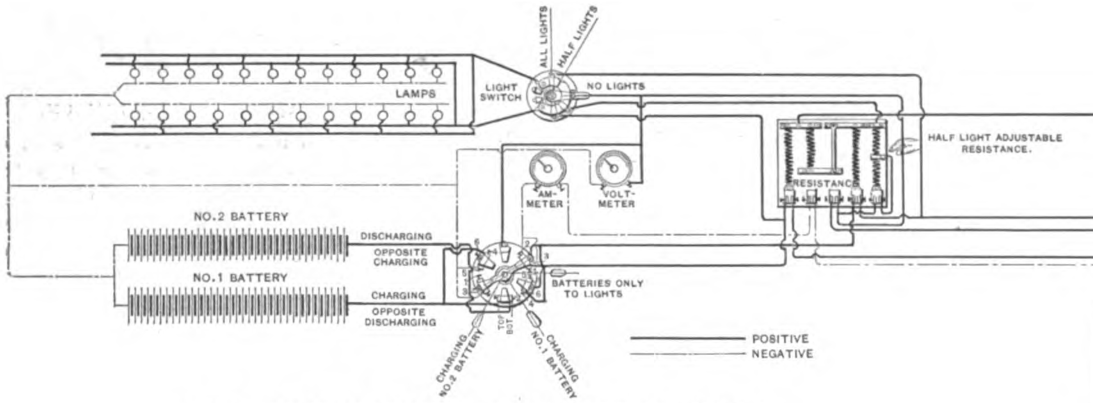


FIG. 4.—DIAGRAM SHOWING ARRANGEMENT OF CIRCUITS

The bearings of the dynamo are lubricated by means of a special form of wick oiler illustrated by Fig. 5. Flat lamp wicking is used and it hangs in two loops, one on each side of the shaft, down into the oil. The bearing at the commutator end has one width of wick and that at the pulley end has two widths, as may be seen in Fig. 3. The pulley is built up of rubber discs, this form being considered to give the best belt grip.

The diagram already referred to (Fig. 4) gives a good general idea of the arrangement of circuits. Fig. 6 shows the three-way battery switch to a larger scale. It can be set for charging battery No. 1 or No. 2, or for supplying the lights from the batteries alone. In the position shown battery No. 1 would be connected up for charging. The lights are wired on the alternate plan, so that either half may be burned alone, or all of them or none.

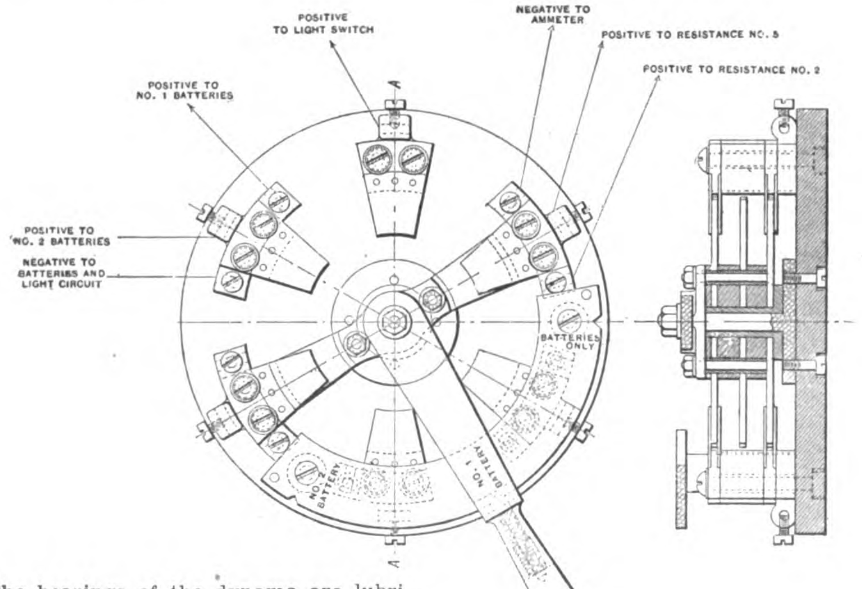
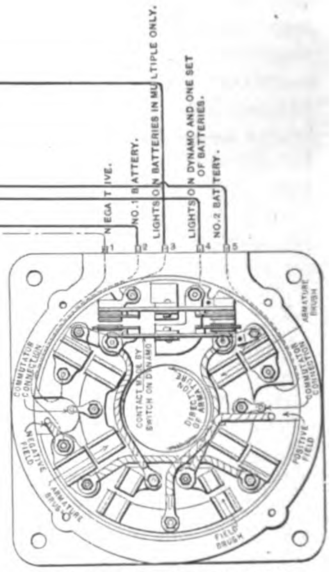

POSITIVE TO LIGHT SWITCH
NEGATIVE TO AMMETER
POSITIVE TO RESISTANCE NO. 5
POSITIVE TO RESISTANCE NO. 2
POSITIVE TO NO. 1 BATTERIES
POSITIVE TO NO. 2 BATTERIES
NEGATIVE TO BATTERIES AND LIGHT CIRCUIT
BATTERIES ONLY
NO. 2 BATTERY
NO. 1 BATTERY

FIG. 6—THREE-WAY BATTERY SWITCH.

A BROAD MOTOR SWITCH PATENT.

During the past few years there has been a strong demand for motor switches, especially in connection with motor starters, which would be provided with automatic protective devices, making it impossible for even the most ignorant operator to cause any damage by improper manipulation of the apparatus. To accomplish this, two independent switch arms have usually been employed; one of which responds to failure of current and the other of which responds to excessive overload current, and in some forms of switch the apparatus is so arranged that the overload circuit-breaker must first be closed before the motor starter can be used to start the motor, the motor starting arm being provided with the usual automatic "no voltage" release.



AUTOMATIC SWITCH BOARD ON DYNAMO.
Am. Elec.

A very broad patent has just been issued to H. Ward Leonard (No. 67[illegible],[illegible]4, dated April 30, 1901), which seems to cover the use of two independent switch levers, one responsive to overload and the other responsive to underload. Claim 6 is a representative one and reads as follows:

> Claim 6. In a circuit-controller, the combination of two movable switch members for controlling the same circuit, and two electroresponsive devices for controlling said switch members, each switch member and its electroresponsive device operating automatically and independently of the other to affect the same circuit, one when excessive current flows and the other upon failure or abnormal decrease of current.

New Apparatus and Appliances

NEW TELEPHONE LINE APPLIANCES.

The cable clip illustrated by Fig. 1 is made of a single piece of zinc, and will accommodate, it is said, the several different sizes of telephone cables; the engraving showing a full-size hanger gripping a ¾-inch cable. As will be noticed, the hanger is very simple and quickly applied. The circular enlargement at one end of the hanger is held against the cable, and the free end is wound around and passed through the lower slot, around the cable again, through the upper slot, up over the suspension wire and hooked into the upper slot, as shown. The free end may also be passed once around the cable, then through the lower slot, passing up over the suspension wire and hooking into the upper slot. Fig. 2 shows an insulated bridle or distributing ring for telephone wires. It is made of iron, heavily coated with enamel, and the wires are inserted or withdrawn at the opening on the side. When applied to brick, stone or ironwork an expanding sleeve (Fig. 3) is provided into which the bridle ring screws directly, the shield expanding at the inner end, and holding the ring rigidly in position. All three appliances are made by James S. Barron & Co., of New York.

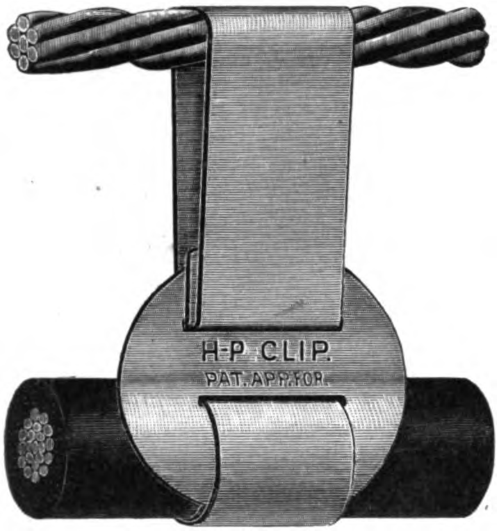


FIG. 1.—CABLE CLIP.

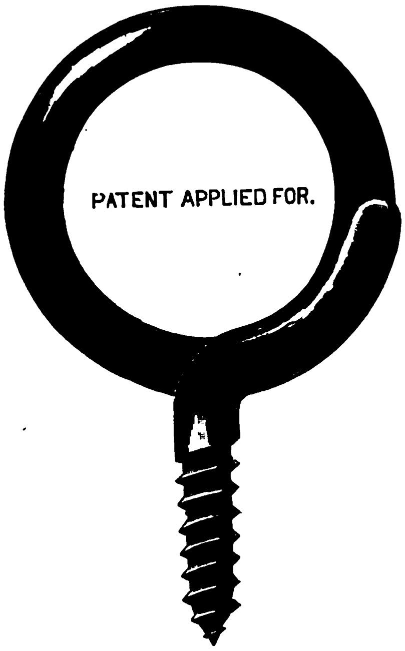


FIG. 2.—DISTRIBUTING RING.

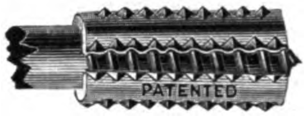


FIG. 3.—EXPANDING SLEEVE.

IMPROVED FUSIBLE RECEPTACLE.

Figs. 4 and 5 show assembled and detail views of a convenient fusible receptacle made by the Novelty Electric Company, of Philadelphia, Pa. The construction is clearly shown in the engraving. A fiber cap, having a hole in its center for the admission of a flexible electrical conductor, screws over a fusible plug, the prong terminals of which fit in sockets mounted in a fiber base and connected to the supply circuit. The base may be set flush with the wall or floor, and since the parts are interchangeable, the convenience of the device is obvious, especially if there are a number of bases placed at different points in a room. Should a fuse blow, the plug terminals are pulled out of the base, the cap unscrewed, and the blown fuse easily replaced. Mica insulation is used on the plug, and all the parts other than the connectors are turned from red or black fiber.

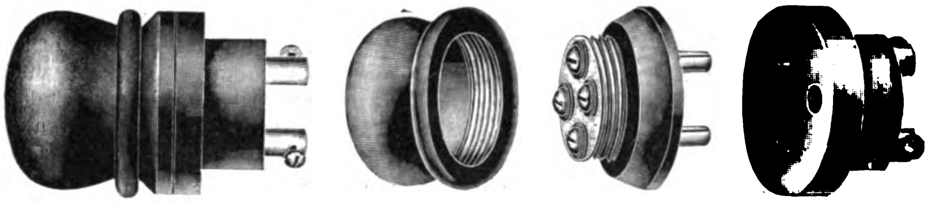


FIG. 4.—FUSIBLE RECEPTACLE AND ITS PARTS.—FIG. 5.

A RESIDENTIAL LIGHTING PLANT.

A diminutive but well-equipped power and lighting plant which is in operation at a commodious Long Island country home is illustrated by Fig. 6. Originally it consisted of the small engine, pump and dynamo shown in the background of the engraving, the larger engine and generator being recently installed. The small engine delivers two horse-power and is belted to a triplex pump having a capacity of 2000 gallons per hour, which pumps water from a number of driven wells to a tank located in the tower of the house. The engine is provided with a second pulley belted to a small dynamo used for charging storage batteries. The larger engine delivers 10 horse-power. Both of these engines were built by Mietz & Weiss, of New York City, and the average consumption of kerosene is said to be three-quarters of a pint per horse-power-hour. The engines are fitted with automatic forced lubrication. An oil well at the side of the cylinder is connected by copper pipes to sight feeds for the cylinders and connecting rod, a small quantity of oil being drawn through the sight feeds at every revolution. The main shaft bearing is supplied with ring oilers supplied with oil from a well situated beneath a phosphor-bronze bushing. An automatic governor regulates the consumption of oil in proportion to the power required. The ignition is effected by compression.

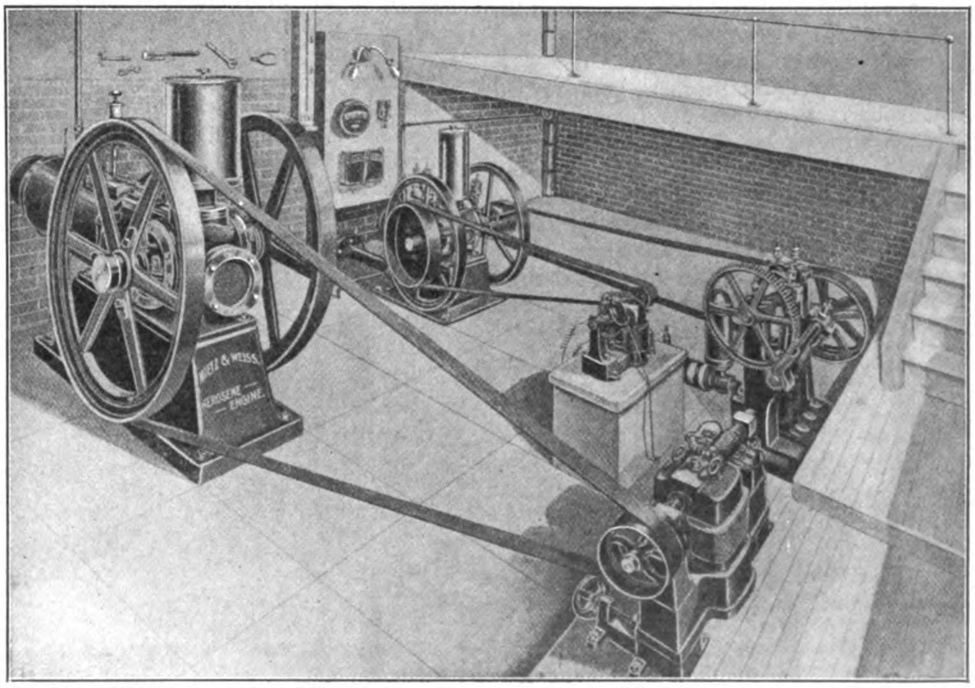


FIG. 6.—VIEW OF RESIDENTIAL LIGHTING PLANT.

PACKING FOR STEAM PLANTS.

Fig. 7 herewith depicts an old ring of "P. P. P." packing which is said to have been in use for 26 weeks on a rod which had previously been packed each week. The packing is made by the Quaker City Rubber Company, of Philadelphia, Pa., who claims that it will retain its elastic character under all conditions, and that it is impervious to the action of steam, oils, acids and alkalies; working as well on heavy mining pumps as on the most sensitive valve stems. The packing is composed of two wedges and a yielding absorbent cushion. The wedges are made of material to stand wear, and are so shaped that they freely slide on each other, compensating, it is claimed, for the wear made by the rod, or inequalities of the rod or box. The cushion absorbs the oil that may be put on the rod, and the combination is said to result in a very elastic packing preventing binding or heating.

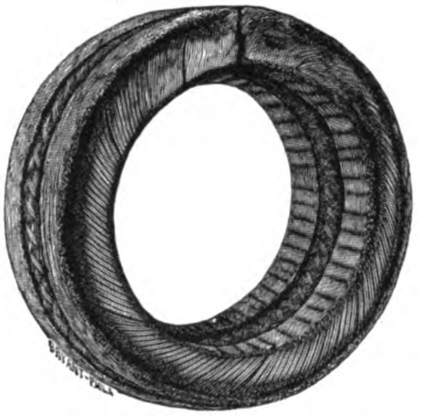


FIG. 7.—RING OF "P. P. P." PACKING.

REGULATOR ALARM COLUMN.

A regulator alarm column with which is combined a low-water alarm is illustrated by Figs. 8 and 9. The device is made by the Clark Brothers Company, of Vicksburg, Mich., and its function is to sound an alarm in the event of the feed-water pump's failure, the supply becoming exhausted, or if from any cause the water falls below normal. The regulator serves to prevent low water and the alarm serves as a check on the former giving notice of the condition should low water exist. Fig. 8 shows the device with the front removed. It is stated that no weight, spring, stuffing-box, connection or joint is used in the mechanism of the feed-water regulator. The valve is of the rotary balance type and is a continuation of the mandrel to which the float is attached. In operation the valve is located in the steam line between the boiler and feed pump. It is actuated directly by the water in the boiler through the medium of the float in the float chamber of the alarm column. Should the water fall, the valve is correspondingly opened and steam is admitted to the pump, which delivers water to the boiler until the proper level is reached, when the valve is again closed by the float. The alarm contact between the alarm lever and the float arm is not made until the low-water limit is reached, when the whistle is blown by live steam from the boiler.

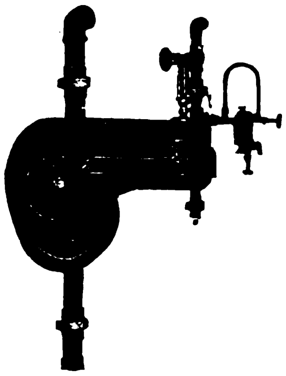


FIG. 8.—INTERIOR OF FLOAT CASING.

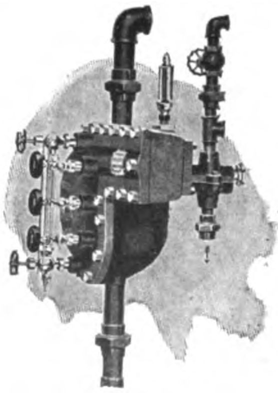


FIG. 9.—REGULATOR ALARM COLUMN.

DOUBLE PLUNGER POWER PUMP.

Fig. 10 shows a double plunger power pump made by the Stewart Heater Company of Buffalo, N. Y. The pump is made heavy and strong for continuous work. It is provided with bronze metal plungers and valve seats and has bronze or hard-rubber valves, with suction and discharge openings on either side. The connecting rods are fastened in the lower ends of the plungers by a peculiar arrangement which permits all wear or lost motion to be taken up by tightening the set screws shown on the upper ends of the plungers. The bodies are not cast on the frames, but are held rigidly in place by machine bolts, so that in case of accident or mishap the body may be moved and a new one put in its place. The shaft is of steel and the bearings are heavily babbitted. The crabs securing the valve bonnets are in halves, so that simply turning a nut brings both the suction and discharge valves into view for inspection.

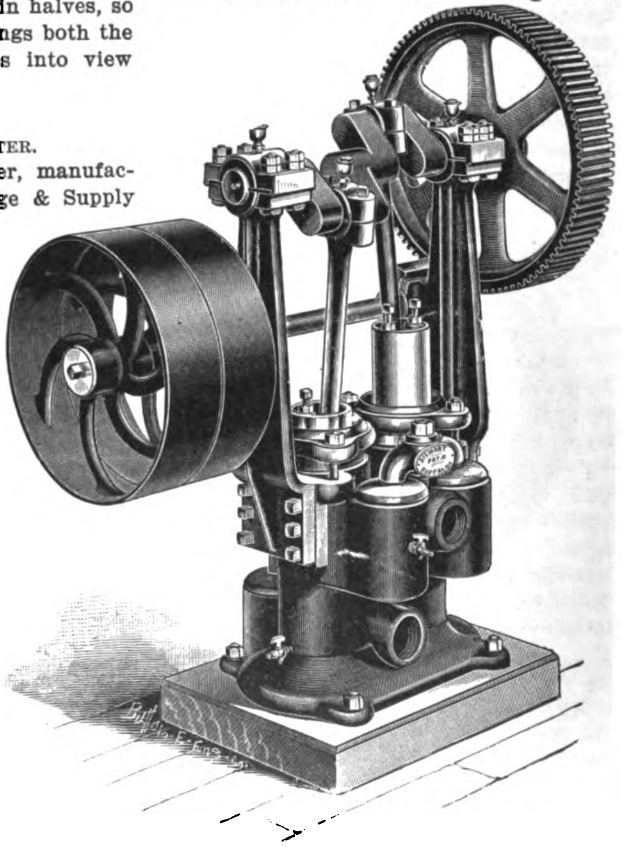


FIG. 10.—DOUBLE PLUNGER POWER PUMP.

WHITE STAR OIL FILTER.

The "White Star" oil filter, manufactured by the Pittsburgh Gage & Supply Company, Pittsburgh, Pa., and shown by Figs. 11 and 12, is said to embody all the essential qualifications of a complete oil filter and purifier of large storage capacity. It is divided by a vertical partition into two distinct compartments connected by a pipe with valve; each compartment having a separate lid, as shown by Fig. 12, enabling the pure oil compartment to be always kept closed and avoiding spattering any dirty oil into the pure oil chamber. The small compartment, comprising one-third of the entire filter, is a receptacle for dirty oil and water, and contains a funnel for receiving the oil and a steam coil for heating the water. The waste oil is first emptied into the funnel shown by Fig. 11, the top of which is fitted with a removable sieve, and is discharged below the surface of the water through holes in the foot of the tube, when it rises owing to its specific gravity being less than that of water. The thinning of the oil by its exposure to the heat in rising through and resting on the surface of the water, is said to cause the precipitation of all the heavy particles of grit and dirt which are flushed out at the bottom of

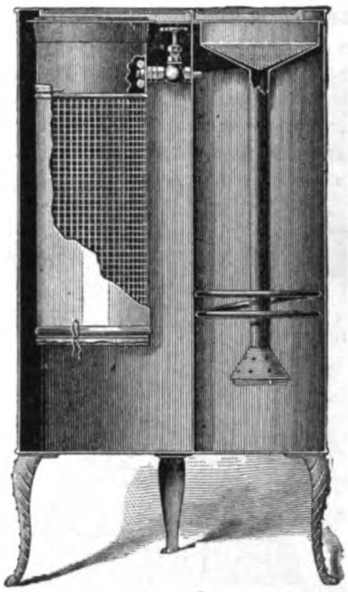


FIG. 11.—INTERIOR OF OIL FILTER.

tank; and owing to the large waste oil capacity of the filter this precipitation is prolonged for some time. When sufficient impure oil has been introduced to reach the level of the inlet pipe it flows into the filter cylinder suspended in the larger compartment, which is a reservoir for the pure oil. This filter cylinder consists of a sheet metal neck and bottom with a section of coarse wire mesh between, around which several layers of specially prepared cloth are wrapped and bound with cords. The oil in passing out of the cylinders percolates through this cloth which forms an essential part of the filter. To clean the filtering cloth all that is necessary is to close the valve in the pipe between the chambers, lift the cylinder out and hold it across the top of the filter, permitting any oil therein to run into the funnel through the hole in the neck. After the oil is drained out of the cylinder it is inverted over the funnel, the flange on the cylinder fitting exactly in the opening and the cloth removed by untying the cords holding it to the cylinder. It is immediately replaced by a clean one kept in a pocket in the cover and the dirty cloth may be washed with soapine in lukewarm water and dried, after which it is ready for use again.

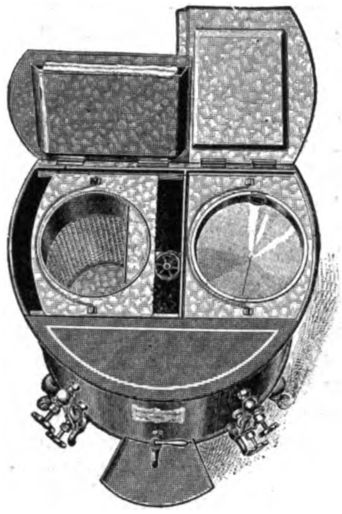


FIG. 12.—TOP VIEW OF FILTER.

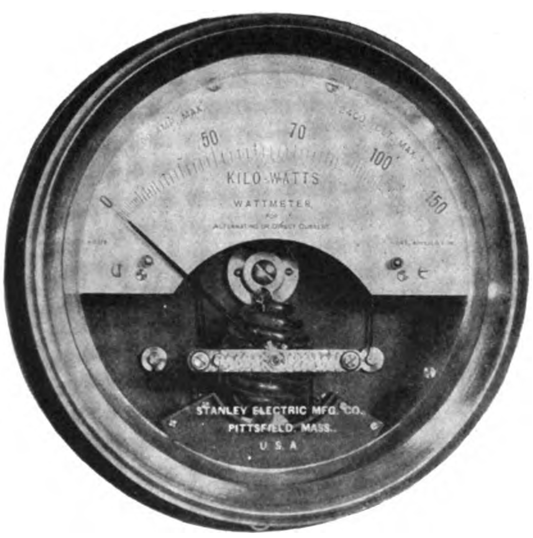


FIG. 13.—SPHERICAL COIL WATTMETER.

SPHERICAL-COIL INDICATING WATTMETERS.

The accompanying illustrations represent an electrodynamometer type of wattmeter for alternating-current circuits which has just been brought out by the Stanley Electric Manufacturing Company. The diameter of the stationary coil of the instrument is tapered from the center toward each end of the helix, as the perspective view, Fig. 13, plainly shows. The potential coil is, of course, suspended within the stationary coil and its motion is transmitted to the pointer of the instrument in the usual way. This coil is mounted in jewel bearings and its movement is damped by an air dash-pot, which is said to make the instrument dead beat. The accuracy is not affected by the frequency or the form of current wave, and of course it is entirely independent of the power factor. Instruments for circuits of 1200 volts and over are equipped with potential transformers, and instruments for circuits carrying more than 150 amperes and having a difference of potential of more than 5500 volts have series transformers interposed between the stationary coil and the line. The diagrammatic illustrations show various methods of connecting up the instrument; the several methods of connection are explained by the inscriptions on the diagrams. It might be well, however, to state that in the diagrams the uppermost and lowermost terminal posts on the instrument represent the terminals of the stationary current coil, while the two posts on the left and right of the pivot represent the terminals of the potential coil. This is true of all four of the diagrams grouped together as Fig. 14.

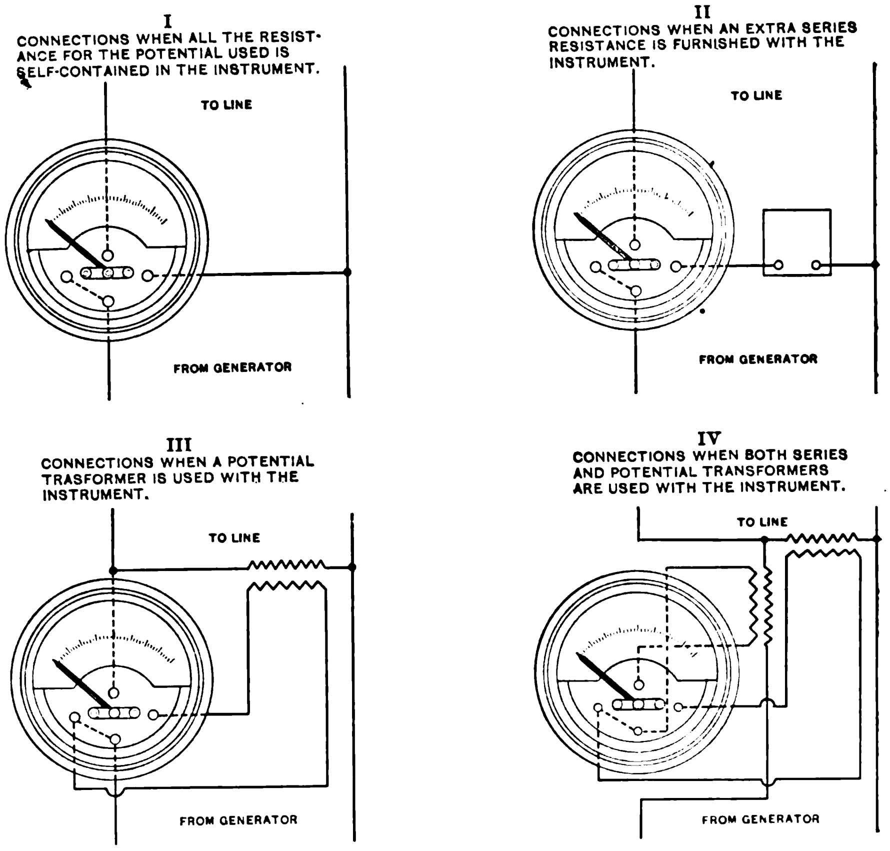

I
CONNECTIONS WHEN ALL THE RESISTANCE FOR THE POTENTIAL USED IS SELF-CONTAINED IN THE INSTRUMENT.
TO LINE
FROM GENERATOR
II
CONNECTIONS WHEN AN EXTRA SERIES RESISTANCE IS FURNISHED WITH THE INSTRUMENT.
TO LINE
FROM GENERATOR
III
CONNECTIONS WHEN A POTENTIAL TRASFORMER IS USED WITH THE INSTRUMENT.
TO LINE
FROM GENERATOR
IV
CONNECTIONS WHEN BOTH SERIES AND POTENTIAL TRANSFORMERS ARE USED WITH THE INSTRUMENT.
TO LINE
FROM GENERATOR

FIG. 14.—DIAGRAMS OF CONNECTIONS.

A LARGE MOTOR STARTER.

The 150-h.p. motor starter shown by Fig. 15 is a good example of a line of apparatus for starting large motors which is now being put on the market by the Cutler-Hammer Manufacturing Company, of Milwaukee, Wis., and Westfield, N. J. It will be noted from the engraving that the current is fed to the motor through a series of laminated type switches instead of the ordinary sliding contact devices usually employed, and the builder claims a number of advantages for this construction. When in the ordinary type of "starting box" the lever is moved so as to engage a contact the initial contact area is nearly zero, as for an instant it amounts to no more than a line. This contact, however, is sufficient to short circuit the resistance step and allow the accelerating current to flow, and the passage of this current when of large volume across the small area of contact causes the sparking and pitting of the contact surface so frequently observed in large sliding-contact starters. The laminated type of switch used by the Cutler-Hammer Company completely obviates this condition, as contact is made over the whole area of surface provided at the instant of closing the switch. In order to keep the contact surfaces bright the laminae of the connecting brush are arranged to work slightly on the contact block in being pressed into contact therewith. In this connection it will be noted that the left-hand or initial switch lever is equipped with carbon blocks, so that the first flow of current through the rheostat passes through auxiliary renewable contacts.

The rheostat is provided with a series

of interlocking blocks or dogs which insure the closing of the switch levers in their proper order, and prevent the accidental closure of any switch before the preceding one has been operated. These blocks also hold the switch levers in their closed position, and are arranged to release them in the same sequence as that in which they were closed, thus throwing any arc which may result from opening the circuit on the auxiliary carbon breaks of the first switch. One point of great importance in the use of this type of starter is the absolutely positive release of the levers and opening of the circuit should the current fail. All of these switch levers resume the open position on the failure of the current, the rheostat is automatically put in condition for the restarting of the motor, and no possibility of the accidental wrong operation noted above exists. When necessary a device is supplied which prevents the closure of a portion only of the switches and renders it impossible to leave part of the resistance continuously in circuit. The resistance conductor supplied with these starters is extremely compact, has a large factor of safety, and is said to be practically indestructible. It is made of cast metal grid of ample cross-section and is insulated throughout with mica.

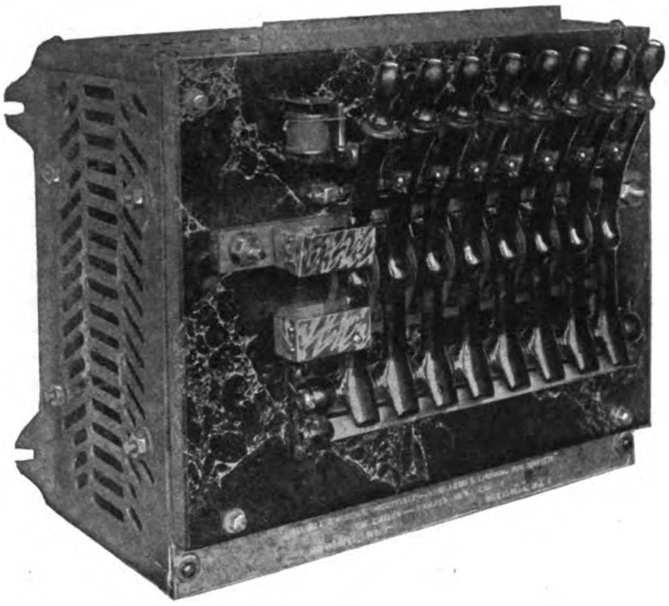


FIG. 15.—MOTOR STARTER.

ENCLOSED MEDIUM SPEED LUNDELL MOTOR.

The accompanying illustration (Fig. 16) shows the latest type of enclosed motor made by the Sprague Electric Company, of New York. It is known as the "S. S." type medium-speed motor, and is made in sizes from 10 horse-power to 60 horse-power. As may be seen from the illustration, it is readily adapted for attachment to the floor, wall or ceiling. The covers are in three sections and removable, thus making the motor either open or enclosed as desired. The bearings are of the self-oiling ring type and are supported by brackets secured to the field frame. It has the usual Lundell feature of a single field coil which energizes all the pole-pieces. The armature core is laminated and of the slotted drum type with the coils rigidly secured in the slots. The commutator is insulated with the best grade of mica, and radial carbon brushes are provided, as usual, with tension springs to press the carbon on the commutator. A hand wheel is provided for the adjustment of the rocker arm. These motors have slide-rails and adjusting screw arrangement for belt tightening and are equipped with a pulley, pinion or coupling, according to the manner of installation.

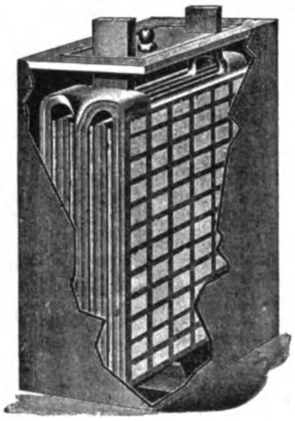


FIG. 17.—"SPECIAL" STORAGE BATTERY.

AUTOMOBILE "SPECIAL" STORAGE BATTERY.

Fig 17 herewith illustrates what the manufacturer terms his "Automobile Special" storage battery. It is built by H. M. N. Muhle, Dayton, Ohio, and contains Mr. Muhle's patent form of one-piece grid, which was described in this paper for May, 1900. The cell here illustrated contains five plates, 4¾ x 7¾ ins., and has a capacity of 42 ampere-hours when discharged at the rate of 10½ amperes. This type of cell, however, is built in five sizes; the other four sizes have 7, 9, 11 and 13 plates, and their discharge rates on the four-hour basis are 15¾, 21, 26¼ and 31½ amperes, respectively. The cells are supplied either complete or by parts.

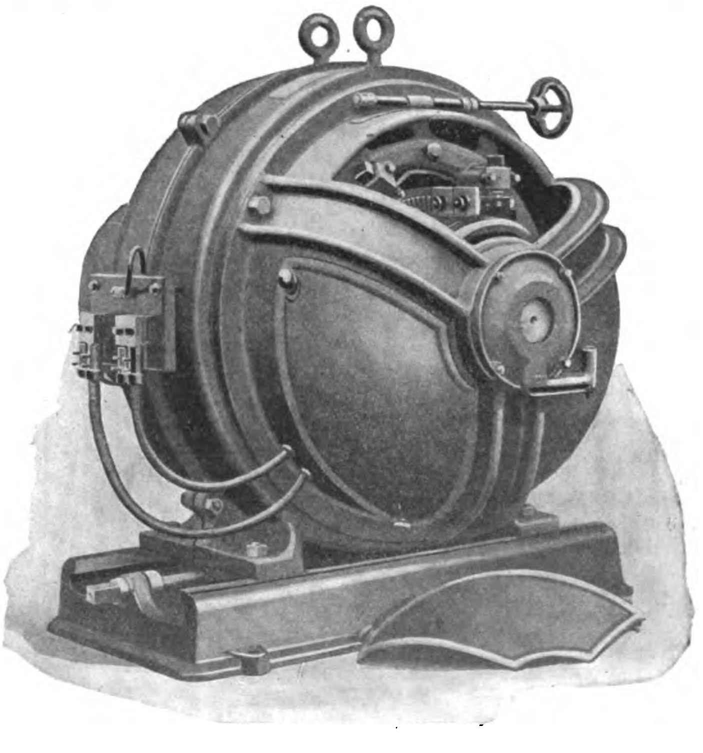


FIG. 16.—ENCLOSED MEDIUM-SPEED MOTOR.

WATER-CUSHIONED TURBINES.

The accompanying illustrations, Figs. 18 and 19, represent respectively the vertical and horizontal forms of turbine built by the Trump Manufacturing Company, of Springfield, Ohio. The vertical type of turbine, illustrated by Fig. 18, embodies a special feature which is said to enable it to operate under any practicable head of water by reason of the fact that the entire weight of the turbine shaft is carried by a water-cushioned thrust bearing, as shown in the engraving, instead of by the ordinary central step. The lower end of the shaft, *A*, is provided with a tapering sleeve, *E*, which rotates with the shaft but leaves the shaft free to move vertically within it. This tapered sleeve revolves in a lignum-vitae bushing, *F*, and merely serves to steady the lower end of the turbine shaft, but does not take its weight. On the shaft immediately above the turbine is mounted a disc, *B*, revolving in a casing which is attached to the framework of the turbine. This casing entirely encloses the disc, *B*, and is provided with holes in its under wall through which the water in the penstock may find access to the chamber in which *B* revolves. Two rings of lignum-vitae, *C* and *D*, are provided, one on each side of the disc. When no water is in the penstock the weight of the shaft and buckets of course forces the disc, *B*, down on the lignum-vitae ring, *D*, but when water is admitted, the pressure of the water on the under side of the disc, *B*, lifts it against the ring, *C*, so that the chamber on each side of the disc is filled with water; the water cannot pass beyond the ring *C* in the upper part of the chamber and allow the shaft to fall by equalizing the pressure on opposite sides of the disc.

When water is turned into the turbine casing, the downward pressure carries the shaft downward just enough to allow the upward pressure of the water in the penstock against the disc, *B*, to balance the downward pressure on the turbine buckets and the disc, *B*, revolves out of contact with both of the lignum-vitae rings. In this condition there is a slight leakage of water around the edge of the disc and through the chamber, which is taken off and delivered to the casing of the turbine by the small pipe shown in the engraving. The surface of the disc, *B*, is made of such an area that the upward pressure of the water in the penstock will overbalance the downward pressure of the water in the turbine case sufficiently to carry a weight about 20 per cent greater than the weight of the shaft and any fixtures that may be attached to it. The builders state that this water cushion will balance the weight of the turbine shaft, together with that of an armature mounted on the upper end of it, under any head where it is possible to operate a generator mounted in this way.

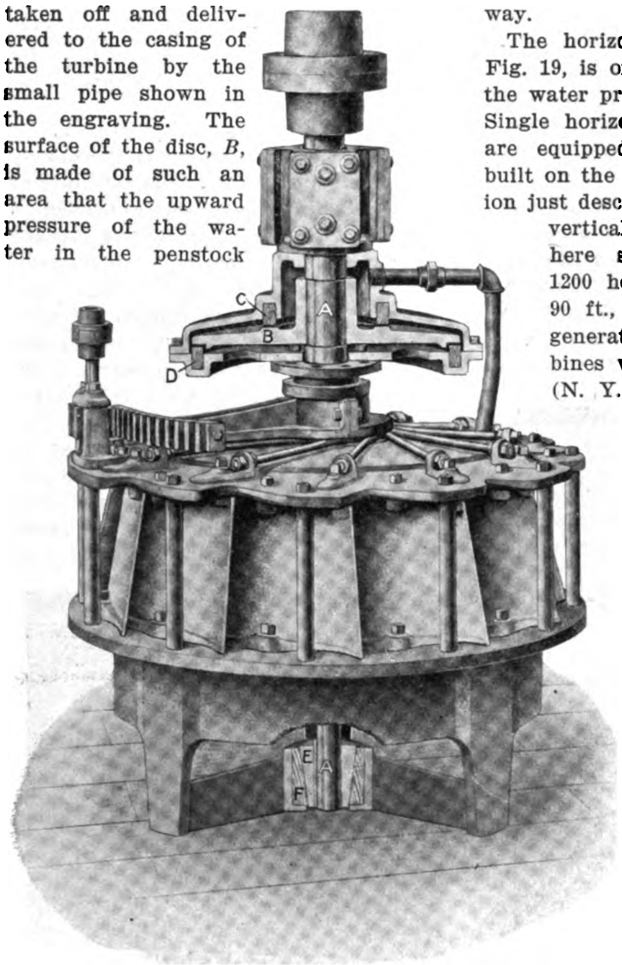


FIG. 18.—VERTICAL TYPE OF TURBINE.

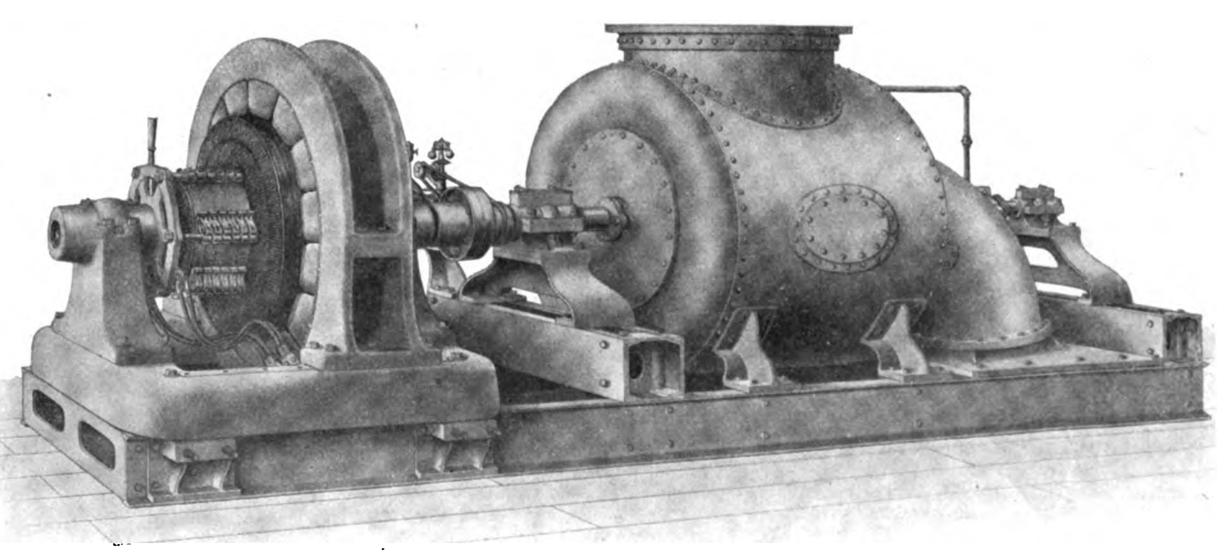


FIG. 19.—HORIZONTAL WATER TURBINE DRIVING DIRECT-CONNECTED GENERATOR.

The horizontal turbine, illustrated by Fig. 19, is of the double variety so that the water pressure is naturally balanced. Single horizontal turbines of this make are equipped with a balancing device built on the principle of the water cushion just described in connection with the vertical turbine. The twin turbines here shown are built to develop 1200 horse-power under a head of 90 ft., and drive a direct-current generator at 200 r.p.m. These turbines were built for the Rochester (N. Y.) Gas & Electric Company. The general base on which are mounted both the turbines and generator is equipped with leveling gears under each of the four corners of the generator frame, by means of which the generator shaft can be brought into accurate alignment with the turbine shaft. On this style of turbine the builders use chain-feed self-oiling journal boxes. The value of the water cushion described above will be appreciated most by users of vertical turbines who have suffered loss and delay by reason of the wearing-out of the familiar lignum-vitae step at some critical time. These steps, of course, wear a long time, but they always fail at the most inopportune time. Moreover, the present arrangement allows the mounting of the generator armature on the end of the turbine shaft without special provision in the way of thrust bearings.

POCKET INCANDESCENT LIGHTING OUTFIT.

A small incandescent lighting outfit which may be carried about in one's pocket, and which is known as the Comead "searchlight" is shown by Fig. 20. It is made by the Comead Manufacturing Company, of Buffalo, N. Y., and consists of a closed nickel-plated brass cylinder which contains the dry batteries furnishing the current, and to the end of which is fastened a cap containing a small reflector and incandescent lamp. As indicated by the illustration, the lamp is lighted by pressing a small button in the cap, which is so connected as to complete the circuit between the lamp and the batteries. The lamp will not light by being shaken about in one's pocket. It is, of course, intended for intermittent use and new batteries can be easily obtained and inserted when the others have run out.

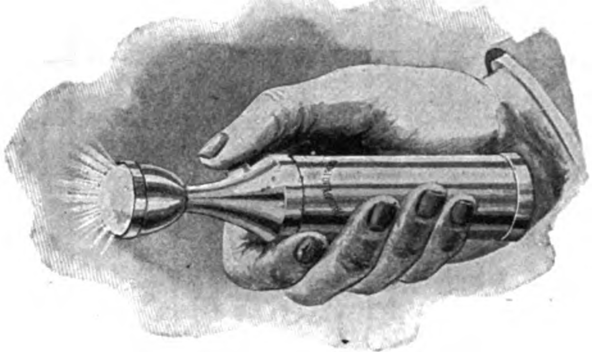


FIG. 20.—COMEAD "SEARCHLIGHT."

"DIAMOND H" FLUSH SWITCHES.

The accompanying engravings illustrate the latest addition to the line of switches manufactured by the Hart Manufacturing Company, Hartford, Conn. Fig. 24 shows a double-pole rotary flush switch, the base of which is made of standard shape and size so that it will fit in the same iron boxes that are used for push switches, and is also adapted for use in the "Diamond H" steel wall cases used in installations in finished residences and other places where provision was not originally made for switches when the building was being constructed. Fig. 21 represents the handle which is used with this switch, and which is of peculiar construction. As a close inspection of the engraving will show, the metal shank of the handle is of the telescoping variety, being normally held within the handle by a helical spring. This arrangement is used in order to relieve the face plate of the switch from any pressure by the rubber handle.

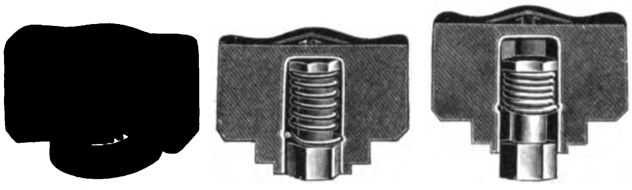


FIG. 21.—DOUBLE-POLE ROTARY FLUSH SWITCH HANDLE.

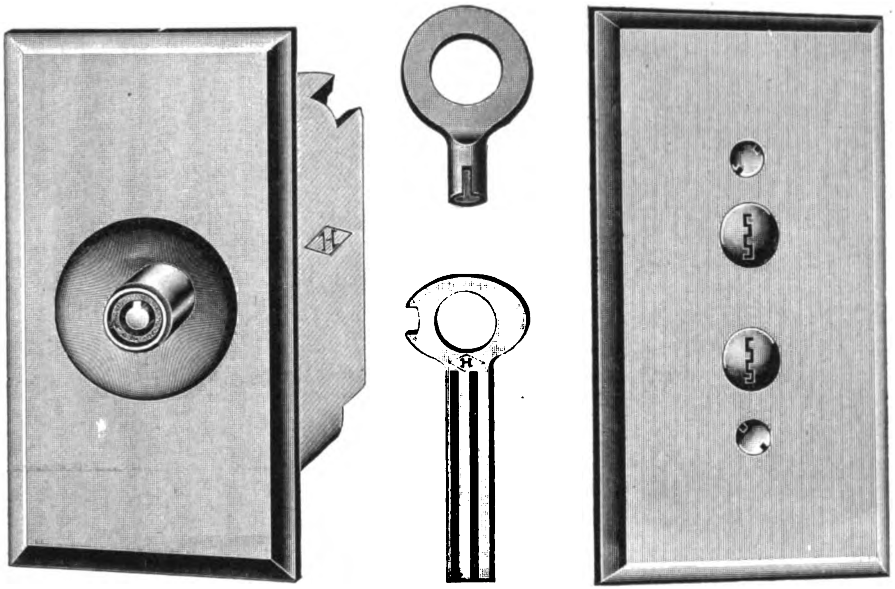


FIG. 22.—DIAMOND "H" LOCK SWITCHES AND KEYS.—FIG. 23.

Fig. 22 illustrates a switch which is precisely like the one shown by Fig. 24 so far as the circuit-controlling mechanism is concerned. It is a lock switch, however, so that instead of the ordinary rubber handle, a key is employed to turn the switch. This illustration also shows the form of face plate used on all of the "Diamond H" rotary flush switches. Fig. 23 illustrates a lock switch of the push variety, the construction of which is well known to all users of electrical apparatus. The feature of the switch is that a flat key somewhat similar to the key of a Yale lock is employed to push over the rocking lever within the switch box. As in the case of all "Diamond H" switches, the ultimate movement of the contact jaws in making and breaking the circuit is removed from the control of the operator and performed by strong springs, giving it the familiar quick-break motion.

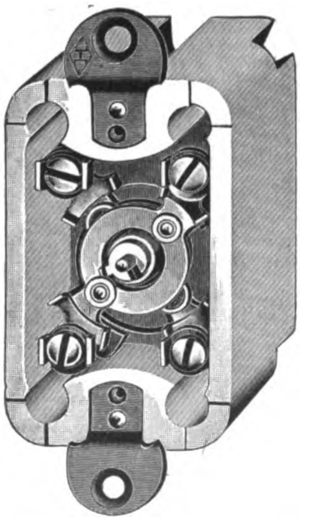


FIG. 24.—DOUBLE-POLE ROTARY FLUSH SWITCH.

NEW INTERIOR TELEPHONE SYSTEM.

With a view to supplying a thoroughly reliable telephone equipment for interior work the Century Telephone Construction Company of Cleveland, Ohio, has engaged in the manufacture of an intercommunicating telephone set as carefully constructed, it is said, as though intended for the most exacting exchange service. The set combines the company's high-grade transmitter, double-pole receiver and full metallic circuit switch. The metallic-circuit switch is illustrated by Fig. 25. The lever arms are insulated from each other by hard rubber, and exert a strong rubbing pressure on the studs. Each circuit is entirely disconnected from the others, except of course when conversation is in progress, so that cross-talk is avoided. The switch is not complicated by the use of any self-restoring device, and the wiring is so arranged that the bell is

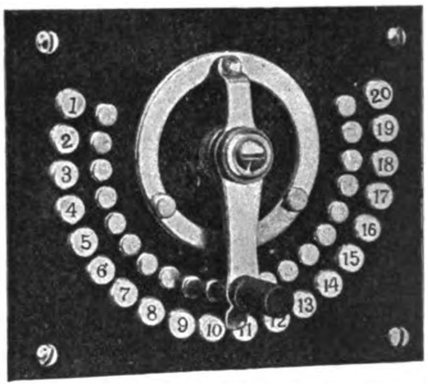


FIG. 25.—FULL METALLIC CIRCUIT CIRCULAR SWITCH.

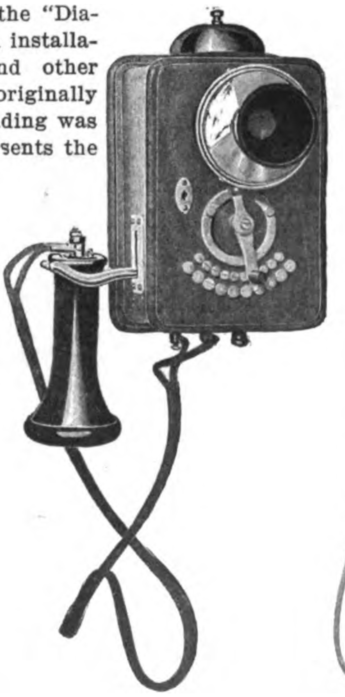


FIG. 26.—WALL SET WITH TEN-POINT SWITCH.

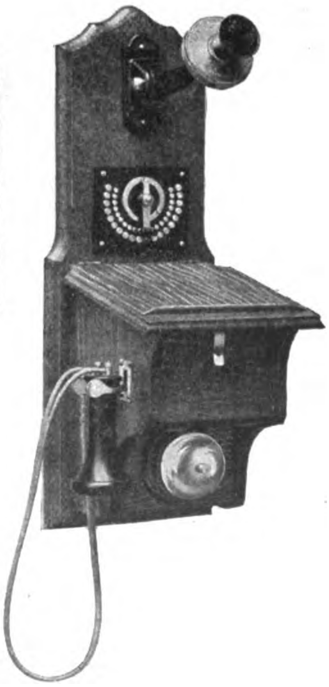


FIG. 27.—WALL SET WITH TALKING BATTERY.

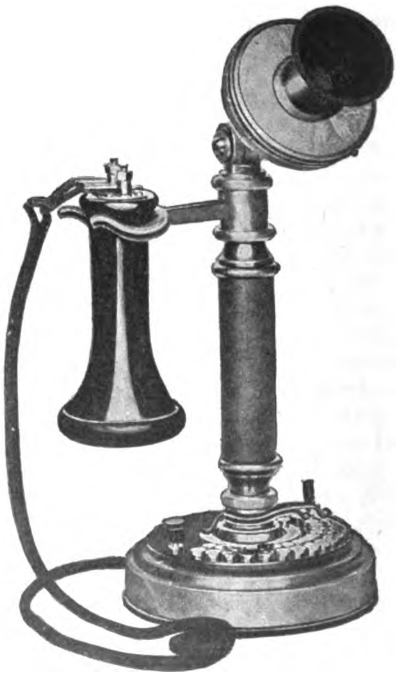


FIG. 28.—DESK SET WITH SWITCH MOUNTED ON BASE.

always on its home line when the receiver is hung up, regardless of the position of the switch. A station is called by merely moving the switch around to the desired number and pressing a button. Fig. 26 shows a wall instrument provided with a ten-point switch, the call being made by the push button shown in the bottom of the box. In Fig. 27 is shown the design of another wall instrument in which the talking battery is placed in the instrument itself with a common central battery for calling. Fig. 28 shows a desk set with the switch mounted directly on the base. This is a highly-finished instrument, the metal parts being nickeled and polished, with a handle of polished hard rubber. As all of the instruments are provided with long-distance transmitters and double-pole receivers the interior system can be switched onto the regular exchange lines without disparaging results.

BATTERY FAN MOTOR OUTFIT.

The Edison battery fan-motor outfit, made by the Edison Manufacturing Company, of New York, is illustrated by Fig. 29. It consists of an Edison battery motor with a 9-in. fan and guard, together with battery cords and four Edison-Lalande cells, type "S," with porcelain jars and contained in a polished oak box. The motor belonging to this outfit is furnished with ball bearings, which, of course, materially decrease the friction loss, and as a consequence the fan is said to run at a higher rate of speed while requiring considerably less current to drive it than is ordinarily the case. The motor with its fan occupies a space 10 x 12 ins., and the makers claim it is noiseless and unusually efficient. The motor is said to run 150 hours on one charge of the battery.

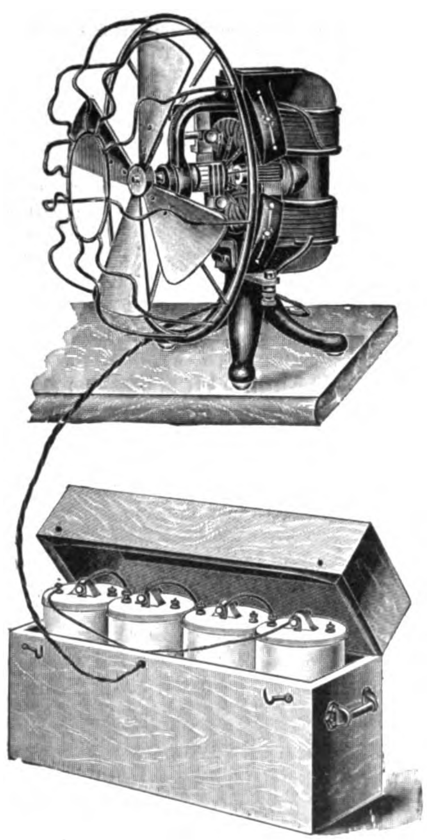


FIG. 29.—BATTERY FAN MOTOR OUTFIT.

PERSONALS.

MR. PHILIP H. TROUT, city electrician of Lynchburg, Va., was a visitor in New York City during the month just closed.

MR. H. F. TATE has established an office at 416 Rookery, Chicago, as the Western representative of the National Conduit & Cable Company.

MR. THOMAS G. GRIER, Western manager for the American Circular Loom Company, has moved into his new offices in the Electrical Building, 128 Jackson Boulevard, Chicago, Ill.

MR. A. A. THRESHER, of the Thresher Electric Company, Dayton, Ohio, was recently in New York supervising the installation of a fine equipment of Thresher machinery at the Brooklyn Navy Yard.

MR. MAURICE HOOPES, formerly of the General Electric Company's staff, and who was in charge of the work of building and starting the third-rail electric road between Albany and Hudson, has joined the staff of the J. G. White Company, New York.

MR. R. B. HAMILTON, who has for the past two months been acting manager for the Packard Electric Company, Ltd., in the absence of Mr. Carey, who has been ill, has been appointed manager of the company to succeed Mr. Carey, whose health has compelled him to give up active work.

MR. R. E. JENNINGS has accepted the presidency of the Menominee Electric Manufacturing Company, Menominee, Mich. Mr. Jennings is a conspicuously successful business man and will push the affairs of his company with all of the energy and persistence that have characterised his previous work.

MR. GEORGE W. FOWLER, of the engineering staff of the C & C Electric Company, has gone to the Pacific coast, where he will supervise the installation of a number of motor equipments for newspaper presses. These equipments will include the C & C series-parallel control which was recently described in the New Apparatus department of this paper.

DR. CARY T. HUTCHINSON, the well-known electrical engineer, was married on April 30 to Miss Susan N. Dimock at the residence of the bride's parents, 25 East Sixtieth Street, New York. Mr. Hutchinson's brother, Mr. Christy Hutchinson, of St. Louis, was the best man. The couple spent their honeymoon at South Coventry, Conn. Dr. and Mrs. Hutchinson have the earnest wishes of the American Electrician's staff for a long and happy life.

MR. JOHN S. SPEER, of the Speer Carbon Company, St. Marys, Pa., was recently married to Miss Helen Mann Fryling. It was a church wedding and a very impressive one. The church was beautifully decorated with potted plants and cut flowers, and the bridal party included the usual quota of ushers. The groom's best man was Mr. Andrew Kaul, Jr. Mr. and Mrs. Speer are spending their honeymoon in visiting several of the larger Eastern cities, and will make their home at St. Marys, where Mr. Speer's business interests are located.

MR. JAMES McLAUGHLIN, of New York, who is now engaged in consulting mechanical and electrical engineering, was one of the earliest workers in the electrical field. Mr. McLaughlin established some of the first arc-light plants that were ever built, and in 1882 was associated with Chas. J. Van Depoele in his historic railway and power transmission work. Mr. McLaughlin remained with the old Van Depoele Company until it was sold out to the Thomson-Houston Company, and has since been engaged in almost every branch of electrical work. His reminiscences of the early days of electrical engineering when definite knowledge was scarce are extremely interesting.

TRADE PUBLICATIONS.

MAPS.—Geo. W. Lord, of Philadelphia, the well-known manufacturer of boiler compound, is issuing pocket maps of the United States, Porto Rico and the Philippines. Any of our readers can get a set by applying for them.

DIRECT-CONNECTED RAILWAY GENERATORS. Westinghouse Electric & Manufacturing Company.—This is circular No. 1044, superseding circular No. 1011, and describing the Westinghouse Company's standard type of direct-connected railway generators. These machines are built in sizes ranging from 150 to 2700 kilowatts output.

BALL ENGINE INSTALLATIONS. The Ball Engine Company, Erie, Pa.—This is a handsome brochure containing half-tone illustrations of plants in which Ball engines are employed, notable among which are the Chicago & Northwestern Railroad shops, Pennsylvania Railroad shops and New York Navy Yard.

DARLING GATE VALVES. The Darling Pump & Manufacturing Company, Ltd., Williamsport, Pa.—This is bulletin No. 1, and is an advance publication pending the issuance of the company's complete catalogue. It contains illustrations and full data concerning Darling revolving-gate valves for 300 lbs. pressure. This type of valve was described in detail in the New Apparatus department of this paper last month.

PROJECTORS, FOCUSING LAMPS, ETC. Chas. J. Bogue, New York.—A well-executed catalogue of standard size containing illustrations and brief descriptions of Mr. Bogue's line of projector arc lamps, which are built for marine, photo-engraving, theatrical and other classes of service.

AN INGENIOUS DEVICE.—The Stephenson Manufacturing Company, Auburn, N. Y., maker of Stephenson bar belt dressing, has devised a very ingenious plan for bringing its excellent product literally before prospective users. It is sending out a card containing appropriate printed matter and also carrying a sample of the belt dressing, which is held in a perforation through the card. This method enables the recipient of the card to see exactly what the dressing is like. The cards are wrapped in thin oiled paper, so that the sample of dressing cannot become displaced, and is not likely to harden.

DIRECT-CURRENT GENERATORS AND MOTORS. Akron Electrical Manufacturing Company, Akron, Ohio.—This is a handsomely-executed catalogue describing the company's well-known line of multipolar machines, which are built both for belt driving and direct connection. The catalogue contains illustrations and brief descriptions of the various machines and their parts, but does not contain any specific data relating to output, dimensions or weights. There are illustrated in its pages, in addition to the generators and motors, a mining locomotive, a booster set, a hoisting outfit and other special apparatus.

ELECTRICAL APPARATUS AND SUPPLIES. Commercial Electrical Supply Company, St. Louis, Mo.—This is a superb catalogue, quarto size, containing illustrations and prices of complete lines of supplies and apparatus. The lines include practically everything that is used in electrical work; telegraph and telephone instruments, dynamos and motors, incandescent and arc lamps, electric-lighting fixtures and shades, electric bells, annunciators and accessories; gas-lighting apparatus and supplies, lightning arresters, switches, street-railway material, commutators and commutator segments, wires, cables, insulating material, cross arms, pins, brackets and other line construction material, tools of all kinds, interior conduit and fittings, glass and porcelain insulators, rheostats, circuit-breakers, etc. It is one of the most complete and attractively prepared catalogues that has come to the reviewer's desk.

VICTOR TURBINES. The Stilwell-Bierce & Smith-Vaile Company, Dayton, Ohio.—This is catalogue No. 23 of the well-known Victor turbine wheels, which are built in all sizes from 6 ins. to 60 ins. in diameter and for all of the usual heads and some that are unusual. This edition of the catalogue is rather an improvement on previous editions, which is saying considerable. The illustrations are mostly artistic and all of them clear.

ELECTRICAL MEASURING INSTRUMENTS. Keystone Electrical Instrument Company, Philadelphia, Pa.—This is catalogue No. 11 of the Keystone Company, containing illustrations, descriptions and prices of instruments for all usual classes of service. The line comprises direct-current portable voltmeters and ammeters built on the plan of the Deprez-D'Arsonval galvanometer; alternating-current voltmeters, ammeters and wattmeters built on the electrodynamometer principle and made direct reading; switchboard voltmeters and ammeters constructed on the same principle as the portable instruments just mentioned; switchboard voltmeters and ammeters of the electromagnetic type for either direct-current or alternating-current circuits; galvanometer-type volt-ammeters for automobile service, and ground detectors for both constant-potential and constant-current circuits. The catalogue also contains extremely useful diagrams of the various instruments, showing their dimensions and in the case of the ammeters, the dimensions of the shunt blocks required. It further contains a most useful chapter on the use and care of electrical measuring instruments which will be found valuable to any user of instruments whether they are of this or some other company's make.

BUSINESS NEWS.

THE NEW EXCELSIOR DRY BATTERY MANUFACTORY of New York has opened a Chicago office at 130 West Jackson Boulevard, which will be under the efficient management of Mr. John W. Brooks.

THE THRESHER ELECTRIC COMPANY, Dayton, Ohio, has opened a New York office at 120 Liberty Street, which will be in charge of Mr. H. H. Smith, who was for many years connected with Blackall & Baldwin of New York.

RICHMONDT ELECTRIC WIRE CONDUIT COMPANY, Milwaukee, Wis., has removed to its new factory at Waukegan, Ill., where it will have considerably increased facilities. The company carries an extensive stock of conduit tubing and fittings at its New York office, 39 Cortlandt Street, and reports that the business of this office is extremely satisfactory.

D. M. STEWARD MANUFACTURING COMPANY, Chattanooga, Tenn., reports that it has more orders in hand and more inquiries than ever before in the 25 years that the company has been established. Extensive additions to the plant are just being completed, which places the company in a position to fill orders more promptly than in the past, and a commodious office building will be erected during the summer.

THE WESTERN ELECTRIC COMPANY reports an unusually heavy demand for fan motors thus far this season. The total sales up to the present have greatly exceeded those of any previous year. The demand from abroad, it is reported, is particularly heavy, unusually large orders having been received from India and other British possessions.

THE W. S. HILL ELECTRIC COMPANY, New Bedford, Mass., reports that it has never been as busy as at the present time and finds great difficulty in keeping abreast of the rush of orders with which it is being favored. The company is constantly enlarging its factory and increasing its working force, but notwithstanding this fact it finds difficulty in keeping up with its business.

THE NEW PROCESS RAW HIDE COMPANY, Syracuse, N. Y., has recently made a considerable addition to its plant, having installed a number of new machines, including three Gleason bevel-gear planers which plane the teeth of bevel gears accurately to cone lines, and one automatic spur gear cutter. The company now has facilities for making metal gears as well as the raw-hide product which is so well and favorably known.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., will have an interesting exhibit in Section F of the Electrical Building at the Pan-American Exposition. This exhibit will include a number of old and curious rheostats which will contrast strongly with the modern types that will also be on exhibition, and will give the visitor an excellent idea of the progress which has been made in the manufacture of this class of apparatus.

ERICSSON TELEPHONE COMPANY, New York, has received an excellent letter of commendation from the United States Signal Office Headquarters at Washington, in which it is stated that "in the early part of 1900 we shipped a lot of telephones of six different makes to Manila for test purposes. The report upon the Ericsson telephone has been favorable." The letter also calls attention to the fact that an order has been placed for 200 Ericsson bridging telephones.

THE MURRAY IRON WORKS COMPANY, Burlington, Iowa, which is one of the oldest established concerns of its kind in this country, is so overcrowded with business that extensive enlargements of the plant have been necessitated. The company has accordingly purchased a large tract of property adjoining its present plant and extensive additions will be made to both the engine and boiler shops. The company already has in full operation two foundries, a large boiler shop, an engine shop devoted exclusively to Corliss engines, and another to the building of hoisting and slide-valve engines.

WESTERN ELECTRIC COMPANY, of Chicago, New York, London and Paris, on May 8 opened its new offices in Philadelphia, which are located at 933 Chestnut Street. The new branch occupies a handsome seven-story structure which will be stocked with a complete line of electrical apparatus and supplies.

THE BULLOCK-WAGNER Sales Organization has established a district office at 1624 Marquette Building, Chicago. This office will be in charge of Mr. H. B. Foster, who has for about two years been connected with the Wagner Company as sales agent. Mr. Foster will have the able assistance of Mr. E. W. Goldschmidt, formerly of the Western Electric Company, in covering this most important field.

GARTON-DANIELS COMPANY, Keokuk, Iowa, reports that large quantities of the well-known Garton lightning arresters are being sent abroad, particularly to Great Britain and France. The company also states that the trade is extremely brisk in its telephone extension circuit devices, which were illustrated and described in this paper last March; in fact, the growth of business in these devices has led to the appointment of local agencies for their sale at various points throughout the country.

THE E. P. ALLIS COMPANY, Milwaukee, Wis., the GATES IRON COMPANY, of Chicago, FRASER & CHALMERS, of Chicago, the DICKSON MANUFACTURING COMPANY, of Scranton, Pa., and THE PENNSYLVANIA IRON COMPANY, of Philadelphia, all manufacturers of steam engines, have entered into a combination, of which it is stated that Mr. Chas. Allis will be the president. The combination will enlarge the Allis plant, just outside of Milwaukee, and the Allis and Fraser & Chalmers works will continue to handle heavy work, while smaller engines are built by the other three plants.

SHAUGHNESSY & COLES is the style of a new firm composed of Messrs. M. J. Shaughnessy and Stephen L. Coles, with headquarters at 5 Beekman Street, New York. The firm has been established for the purpose of preparing and publishing technical and trade literature and advertising "copy" for manufacturers and others who desire efficient assistance in such matters. The relation between this firm and its clients is very similar to that existing between a lawyer and his clients. Mr. Shaughnessy has had wide experience in this line of work. He organized the advertising department of the New York Wanamaker store when it was established, and also prepared the advertising matter for the first Electrical Show at the Grand Central Palace in 1896. Mr. Coles is well known throughout electrical circles, having been for twelve years managing editor of the "Electrical Review." His long experience in this field equips him admirably for

A COMMUTATOR NECESSITY.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.
50c. per Stick. $5.00 per Dozen.

For Sale by all Supply Houses.
Upon receipt of this coupon we will send FREE, sample stick.

Name..
Address..
A. E.

K. McLENNAN & CO.
Sole Manufacturers,
900-100 Washington Street, CHICAGO.

the work of taking care of the needs of manufacturers in the matter of advertising literature and methods.

THE HARTFORD FAIENCE COMPANY, Hartford, Conn., is doing some fine work on delicate porcelain pieces for electrical uses. It has a plant of a large capacity and is at present keeping three 10 ft. 6 in. kilns busy on electrical porcelains. It is devoting its energies to the specialties difficult of production, rather than to the simpler pieces, and the results shown appear to justify this course.

THE STANDARD AUTOMATIC GAS ENGINE COMPANY, Oil City, Pa., recently received an order from the Union Traction Company, of Philadelphia, for a 1000-h.p. double-acting tandem gas engine to be direct-connected to a General Electric standard railway generator, and to operate under a fuel consumption guarantee of one pound of coal per horse-power hour, using Taylor producer gas. This order, it is stated, will be followed by orders for six other engines of the same size.

RUBEROID FLOORING.—One of the features of the equipment of the new offices of The Standard Paint Company, at 100 William Street, New York, is the use of P & B "Ruberoid" flooring; the floors of the big offices are throughout covered with this material. One of the old offices in John Street was several years ago floored with Ruberoid, handsomely decorated. Not only was the experiment successful, but when the company was obliged to find more commodious quarters for its rapidly increasing business and moved to William Street, the old Ruberoid flooring was found to be in such good condition as to warrant its transfer to the new quarters, where it is now doing duty, apparently as good as new. The new offices are so much larger than the old that much more Ruberoid is required to cover them. It makes a pleasant walking surface, being elastic and not so resisting as wood or oilcloth, and deadening the ordinarily harsh sound of footsteps. It is said to be absolutely water, acid, alkali and vermin proof, odorless and pleasant to handle, and easily kept clean. Handsome designs can be painted upon it. Its durability and economy make it a very appropriate flooring for mills, factories, breweries, engine rooms, etc., while its neat appearance renders it entirely acceptable as a flooring for stores, offices, etc.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, reports that its business thus far this year exceeds that of the same period for any other year since the company has been established. Among recent sales that have been booked is an order for a 200-kw. generator for the Laclede Gas Light Company, St. Louis, Mo., this being the third Triumph machine of this size that the Laclede company has ordered within the past six months. Other orders are: A 200-kw. direct-connected generator for the Globe-Wernicke Company; a 60-kw. generator, three 10-h.p. motors, one 15-h.p. motor, and one 5-h.p. motor for the Heer Shoe Company, Portsmouth, Ohio; a 75-kw. direct-connected generator for the village of Perham, Minn.; a 100-kw. direct-connected generator for the Garretson Hotel Company, Sioux City, Iowa; two 100-kw. slow-speed belted generators for the R. & H. Simon Company, Easton, Pa.; a 100-kw. generator, three 25-h.p. motors, two 15-h.p. motors and three 10-h.p. motors for the Newport Rolling Mills, Newport, Ky.; two 50-kw. generators for the Carroll Electric Light Company, Carroll, Iowa; one 80-kw. generator for the Manning Electric Light Company, Manning, Iowa; and a 300-kw. slow-speed belted generator for M. A. Bradley, Cleveland, Ohio.

THE KELLOGG SWITCHBOARD & SUPPLY COMPANY, Chicago, reports a steady increase of business in all departments. A few months ago 10,000 sq. ft. of additional floor space were added to the company's already large and well-equipped factory, and arrangements have been recently made for the addition of 21,000 sq. ft. more. This space will be equipped with the most modern machinery, and will facilitate the handling of orders with even greater promptness than heretofore.

The small switchboards of the "Express" type which this company recently put on the market have proven very popular, and are in great demand, orders for over fifty having been received since March 15. Among the orders for small switchboards varying in size from 50 to 300 lines each, recently received, are the following: Williamsburg, Pa.; Russell, Ia.; Somerset, Pa.; Chrismaw, Ill.; Webster, S. D.; Grandbury, Tex.; West Chester, Pa.; Bartelsville, I. T.; Bishop Hill, Ill.; Woonsocket, S. D.; Tama, Ia.; Royersford, Pa.; Columbus Junction, Ia.; Little Rock, Ark.; Marco, Ind.; Shawnee, Ohio; Canadian, Tex.; Troy, Ind.; Savannah, Ill.; Chadwick, Ill.; Black River Falls, Wis.; Astoria, Ill.; Concordia, Kan.; Ashland, Ky.; Blue Rapids, Kan.; Greenleaf, Kan.; Huntingburg, Ind.; Virginia, Ill.; Logan, Kan.; Hurley, S. D.; Sparta, Ill.; Miltonville, Kan.; Scandia, Kan.; Streitsville, Ohio; Lexington, Miss.; Story City, Ia.; Versailles, Mo.; Dalton, Ohio; Doylestown, Pa.; West Grove, Pa.; Westphalia, Ind.; Linton, Ind.; Clifton, Kan.; Sanborn, Ind.; Estelline, S. D.; San Francisco, Cal.; Joy, Ill.; Blue Earth, Minn.; Augusta, Ill.; Sullivan, Ind.; Dawson, Minn., and Wellsboro, Pa.

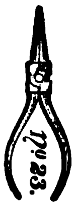
THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, at its recent annual meeting of stockholders, voted almost universally for the re-election of the old board of directors, consisting of Edward F. C. Young, John A. Walker, Daniel T. Hoag,

9010-Cortlandt
9000-Harlem
9040-38th St.
are the call numbers of the
Contract offices of the
New York Telephone Company
Calls for these numbers from any Manhattan Station are FREE.
Information regarding telephone service and rates cheerfully furnished.
NEW YORK TELEPHONE COMPANY,
15 Dey Street.
215 West 125th St. 111 West 38th St.

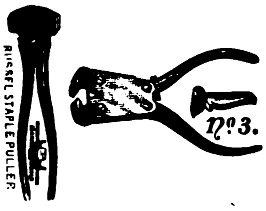
CREAM FLUX
An Absolutely Non-Corrosive Insulating Soldering Flux FOR ALL METALS.
So EASILY APPLIED that all CAN USE IT.
So CHEAP that all SHOULD USE IT.
So EFFICIENT that all MUST USE IT.
PUT UP IN CANS AT
15c., 25c., 45c. and 75c.
SPECIAL PRICES IN QUANTITY.
SEND FOR TRIAL BOX.
Endorsed by the National Board of Fire Underwriters and all users.
We guarantee it, and if not satisfactory, money will be refunded.
FOR SALE BY ALL SUPPLY HOUSES OR
CREAM FLUX CO., SOLE MANUFACTURERS, 100 Washington St., CHICAGO

BIG STICK, 35 CENTS.
Sample Free.
SOUTHWORTH & HARE,
Indianapolis, Ind.

ERICSSON
Means best. Satisfaction guaranteed. No buzzing. Talks clear and distinct. Of neat appearance.
CATALOGUE FREE ON APPLICATION.
Ericsson Telephone Co., 296 Broadway, N. Y. City.



NIPPERS
that will cut anything and can be used for all kinds of work.
Utica Drop Forge & Tool Co.,
296 Broadway.



PLYERS
made of boracic steel are the very best. Try them and see for yourself.
SMITH & HEMENWAY CO.,
New York.

PLATINUM
PLATINUM FOR CONTACT POINTS IN ELECTRICAL INSTRUMENTS.
PLATINUM FOR TELEPHONES. PLATINUM FOR ELECTRICAL INSTRUMENTS.
We sell PLATINUM in any quantity, either large or small. We buy PLATINUM, or anything containing PLATINUM, in any quantity.
FOR INCANDESCENT LAMPS AND EVERYTHING ELSE.
BAKER & CO.
MANUFACTURERS OF PLATINUM IN ALL SHAPES.
Newark, N. J. New York Office, 120 Liberty St.

Richard Butler, William Murray, E. L. Young and Joseph T. Bedle. The board of directors re-elected President E. F. C. Young, Vice-President and Treasurer Walker and Secretary Geo. E. Long. Judge Joseph Bedle was also re-elected as counsel for the company.

JAMES LEFFEL & CO., Springfield, Ohio, builders of the well-known Sampson turbines, have been obliged to increase their manufacturing facilities on account of the enormous growth in business. Extensive additions are now being made to the plant which will include a complete electrical equipment for lighting and power purposes.

HONORS FOR THE INTERNATIONAL CORRESPONDENCE SCHOOLS.—When the National Export Exposition in Philadelphia was organized, its officers selected the Franklin Institute through which to make awards to exhibitors. The International Correspondence Schools of Scranton had an exhibit at this exposition and has received for this exhibit the highest award, consisting of a diploma and a silver medal. An interesting and significant feature of the award is that the diploma states that the award is made for "a unique, thorough and comprehensive system of technical education by correspondence." When it is remembered that a Franklin Institute award couched in entirely general terms would be a prize of considerable value, it will be understood that the phraseology of the diploma makes this award of unusual value. The award was made after a personal visit of investigation to the Correspondence Schools by Mr. John P. Birkenbine, president of the Franklin Institute.

THE WESTERN ELECTRICAL SUPPLY COMPANY, of St. Louis, reports that the success with which it has met in introducing the new G. I. flush push-button switches is extremely gratifying. This switch is designed to obviate many of the difficulties encountered in other switches. The mechanism is of a peculiar construction which insures absolute certainty of a quick make and break of the contact parts. After the button has been pushed to a certain distance, the making and breaking of the contact is absolutely beyond the control of the operator's hand. This special construction of the moving parts is a further advantage in avoiding the possibility of the switch being left on any dead center. The company has also got out an electric time switch by the use of which the lights, in connection with the clock, can be set to turn off and on at any time required. When once set it operates continuously, needing no attention except winding every eight days. The switch is especially adapted for show windows, store rooms, advertising signs, etc. It is claimed that by the use of this switch the cost of lighting will be reduced at least 75 per cent. The switch is operated by a handsome eight-day clock with double spring lever and large eight-inch dial, mounted with an attractive nickel-plated case. The company states that the business in its lighting supply department has never been better.

THE NEW ENGLAND ELECTRIC MANUFACTURING COMPANY, Boston, Mass., was organized under the State laws of Massachusetts on May 2, with an authorized capital of $30,000, all paid in. The officers of the new company are Geo. O. Proctor, president; Guy H. Proctor, vice-president and manager, and Chas. A. Haskell, treasurer. This company succeeds to the business of the Anchor Electric Company, with which Mr. Guy Proctor has been connected for the past five years. The new company starts out under excellent auspices and should receive a full share of patronage in its field.

WILLIAM ROCHE, New York, manufacturer of the new Standard dry battery, has just received from the Naval Torpedo Station at Newport, R. I., an excellent and gratifying letter showing the results of a test made of his batteries at that station by Lieut. Commander Hodgson, U. S. N. The letter, which is signed by N. E. Mason, Commander, U. S. N. Inspector of Ordnance, in charge, says in part: "Referring to tests made of the Roche Standard dry cell, the tests made show that the manufacturer sustains the reputation he has acquired for producing a most excellent and satisfactory dry cell. In recuperative power it shows a marked advance over previous cells. It was placed on a dead short-circuit for 30 hours and when taken off was dead, reading only 0.1 on voltmeter. After remaining on open circuit for nine days it was tested and showed 1.2 volts with an internal resistance of 1.1 ohms, quite enough current to fire a primer. On this date, eight days later, though the internal resistance has increased to 1.6, the cell is still able to do the work that would be required of it in a firing battery." Business has increased to such an extent with Mr. Roche that he has three times increased his factory to take care of his rapidly extending business. In addition to his regular line of dry batteries of various sizes, his gas engine generator set for automobiles and other purposes to which a gas engine is put, is meeting with gratifying success.

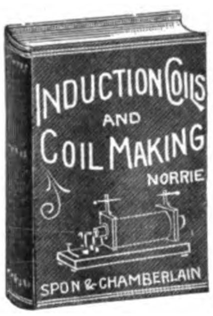
ELMER G. WILLYOUNG, New York, reports that business is very brisk in all of his lines of high-grade instruments, and particularly in the branch of photometric and cable-testing apparatus. The new No. 1 Willyoung station photometer is attracting considerable attention among central-station men by means of its quickness and simplicity of operation. One of these instruments has been shipped to Vanderbilt University, Nashville, Tenn., and others are in process of construction to fill orders. Two very large cable-testing outfits were recently shipped, one to the Crescent Insulated Wire & Cable Company, Trenton, N. J., and one to the U. S. Signal Office on Governor's Island. The Government also purchased recently two shipments of galvanometers and condensers for cable work, which have been sent to the Philippine Islands. Mr. Willyoung also reports increased trade in X-ray apparatus.

SOLID TRAINS TO NORTHERN MICHIGAN.

The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

PRATT INSTITUTE
BROOKLYN, N. Y.
TWO YEAR COURSES IN
Applied Electricity
AND IN
Steam and Machine Design
Write for Catalogue and Particulars.


INDUCTION COILS AND COIL MAKING
NORRIE
SPON & CHAMBERLAIN

CLOTH, $1.00.

New edition thoroughly revised and brought up to
Latest American Practice
Induction
COILS.
BY H. S. NORRIE.
How to Make, Use and Repair Them.
Including Ruhmkorff, Tesla, Medical, Gas Engine and Spark Coils for all purposes, and chapters on Electric Gas Lighting and Wireless Telegraphy.
Nearly 300 pages, fully illustrated, with many original diagrams.

NOW READY.
THOMPSON'S Polyphase Currents.
Very much enlarged, with 24 COLORED illustrations, 8 folding plates and 500 pages of text. Cloth, $5.00. *Send for full descriptive circular.*
SPON & CHAMBERLAIN, Publishers,
12 Cortlandt St., New York.

THE MASON
Reducing Valves
ARE THE WORLD'S STANDARD VALVES
For automatically reducing and absolutely maintaining an even steam or air pressure.
They are adapted for every need and guaranteed to work perfectly in every instance.
Write for full information and splendid references.
THE MASON REGULATOR CO. Boston, Mass., U. S. A.

The Best Made.

COMEAD SEARCH LIGHT
You can pick it up at any time, and by simply pressing button, light up any object within fifty feet. Retails at $3.00. New batteries 25c. Can be easily inserted. Each battery can be used several hundred times. Sample sent prepaid on receipt of $2.00. COMEAD MFG. CO., Buffalo, N.Y.

The Easiest Sold.

American Electrician.

Vol. XIII. New York, July, 1901. No. 7.

A WATER-POWER RAILWAY PLANT WITH ALTERNATING-CURRENT TRANSMISSION.

TRANSMISSION PLANT AND SUB-STATIONS OF THE KALAMAZOO VALLEY ELECTRIC COMPANY.

The Kalamazoo Valley Electric Company operates an extensive long-distance transmission system supplying electric light and power to sub-stations at Allegan, Otsego, Kalamazoo, Augusta and Battle Creek, Mich. It takes its power from the Kalamazoo River, the generating plant being located at Trowbridge, five miles east of Allegan. From the power house one transmission line runs northwest to Allegan; the other runs southeast to Otsego and Kalamazoo and from there east to Augusta and Battle Creek. Kalamazoo is 22 miles and Battle Creek 46 miles from the power house. The transmission e.m.f. is 25,000 volts. The power plant is located at a dam on the Kalamazoo River which gives a head of 23 ft.; the dam is of wood with stone filling. A view of the dam, power house and flood gates is shown in Fig. 2. There are three 13 x 12-ft. Taintor flood gates, which are raised by a crab located in the small extension at the right-hand end of the power house; this extension is directly above one of the flood gates, and the crab is arranged to be run out on tracks over the other two gates. The pond formed by the dam covers 600 acres and backs up the river about six miles.

The wheel pit, the interior of which is shown in Fig. 3, contains four pairs of 45-in. horizontal Samson turbines all coupled to the same shaft and direct-connected to a 1500-kw. generator. Each pair discharges into an 8-ft. draft-tube, and each draft-tube discharges into an elbow which has a horizontal outlet on the down-stream face of the structure. The turbines were built by James Leffel & Co., of Springfield, Ohio, and have a combined rating of 2800 horse-power. Two pairs of the wheels are controlled by a Lombard

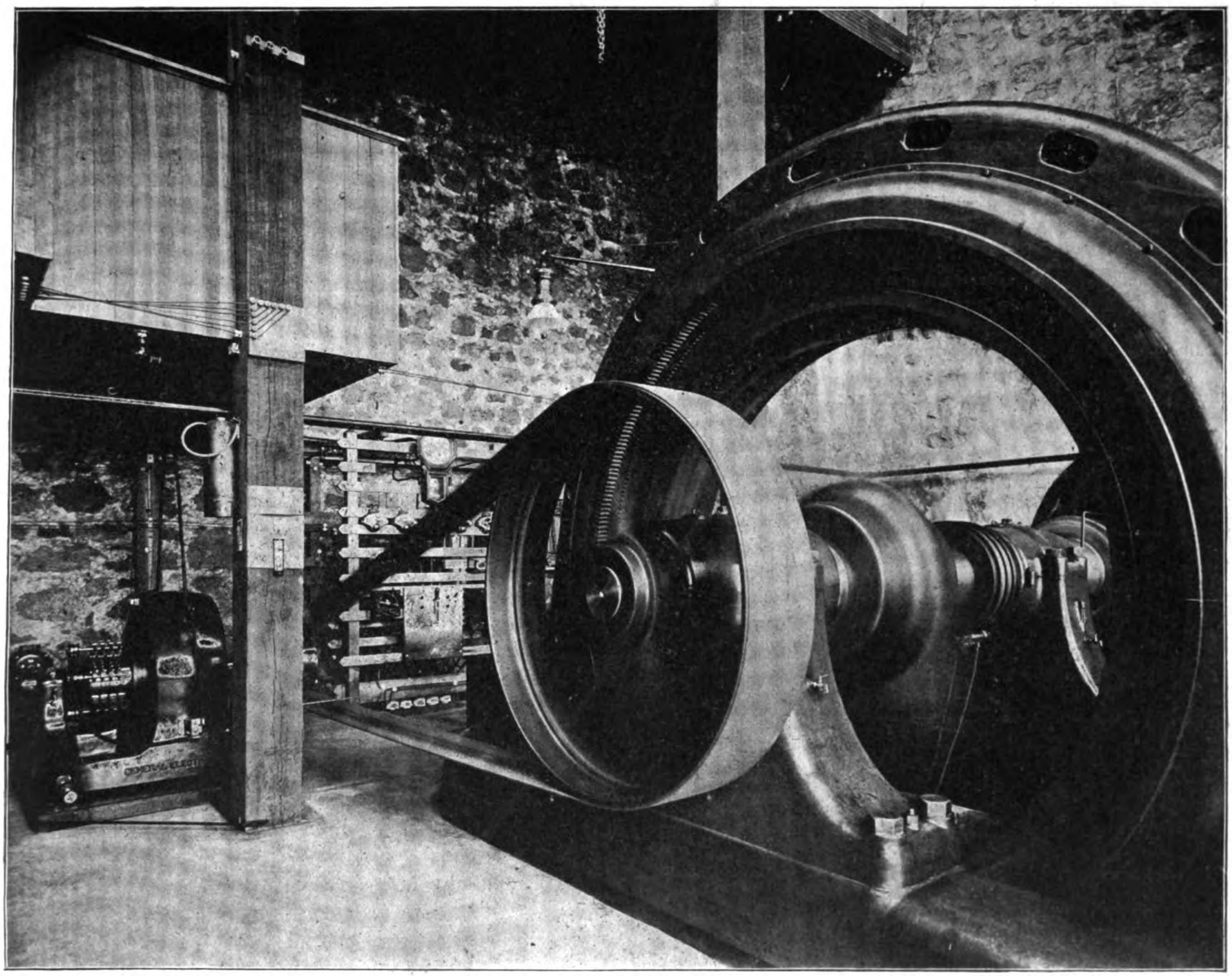


FIG. 1.—DIRECT-DRIVEN REVOLVING-FIELD ALTERNATOR, EXCITER AND SWITCHBOARD.

governor and the other two by hand. The 10-in. shaft passes from the wheel pit through a stuffing box in the wall into the generator room. The Lombard governor, which is located in the generator room, is shown in Fig. 4.

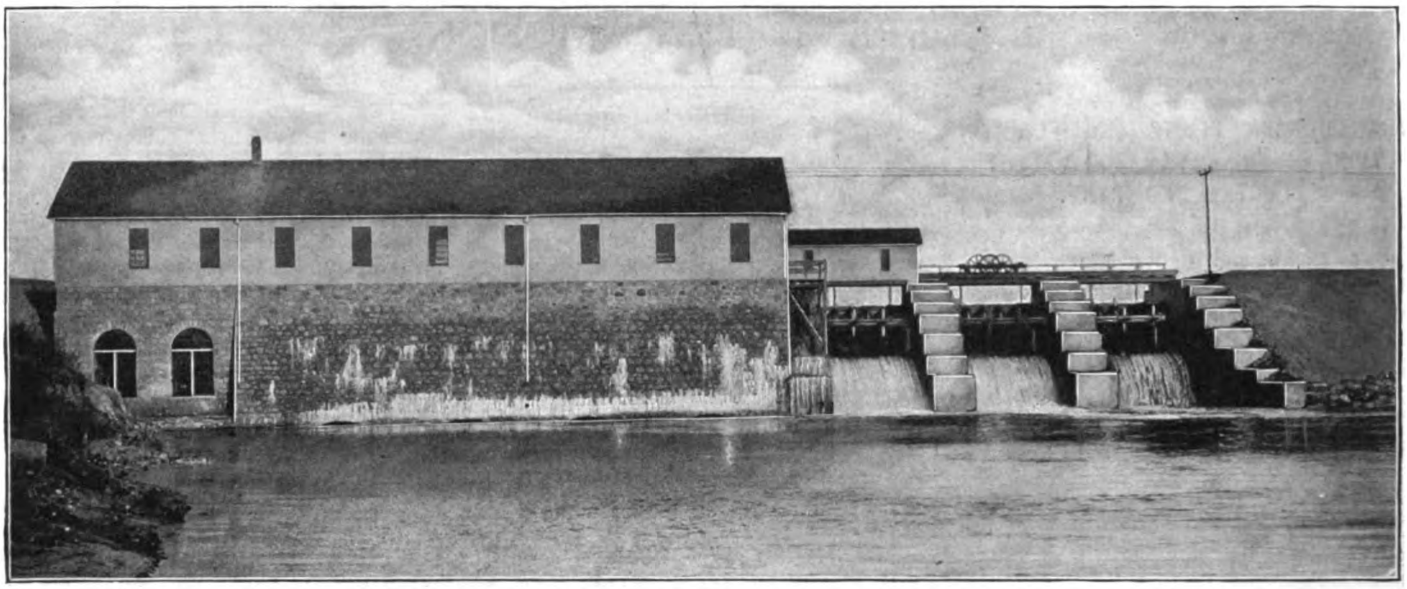


FIG. 2.—POWER STATION AND DAM AT ALLEGAN.

The generator is a 1500-kw. three-phase General Electric machine with a revolving field magnet; it runs at 180 r.p.m. and delivers current at 2300 volts and 60 cycles. It is shown in Fig. 1, together with the exciter and the switchboard. It is not often that a power plant of this size puts "all its eggs in one basket" to the extent of depending on only one generator, and frequent interruptions from this cause were freely predicted when the plant was started, but its record has been very good. At times the generator runs for four months continuously without being shut down. In summer it cannot run as long as this because of the accumulation of very small bugs in the armature and field windings, which must be frequently cleaned out. When the machine is shut down it is done at a time when the old steam plants at the sub-stations can carry the load. The generator switchboard is extremely simple, containing only an oil break switch and automatic circuit-breaker and voltmeters and ammeters. The current is raised to 25,000 volts by a bank of three General Electric oil and water-cooled transformers of 500 kilowatts capacity each. The circulating water is supplied by a Worthington pump driven by a 1-h.p. direct-current motor which receives current from the exciter.

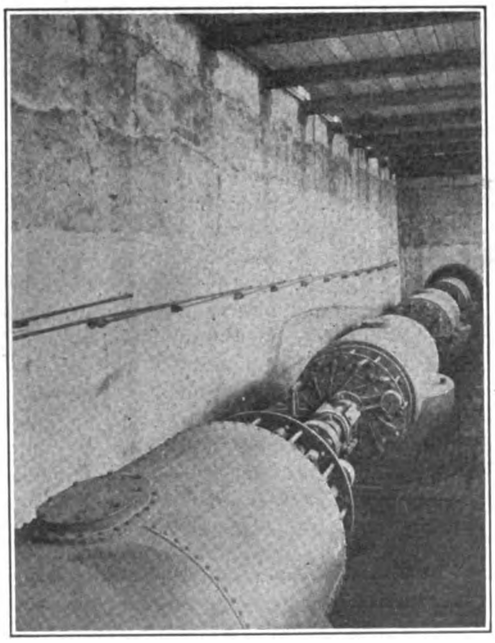


FIG. 3.—VIEW IN THE WHEEL PIT.

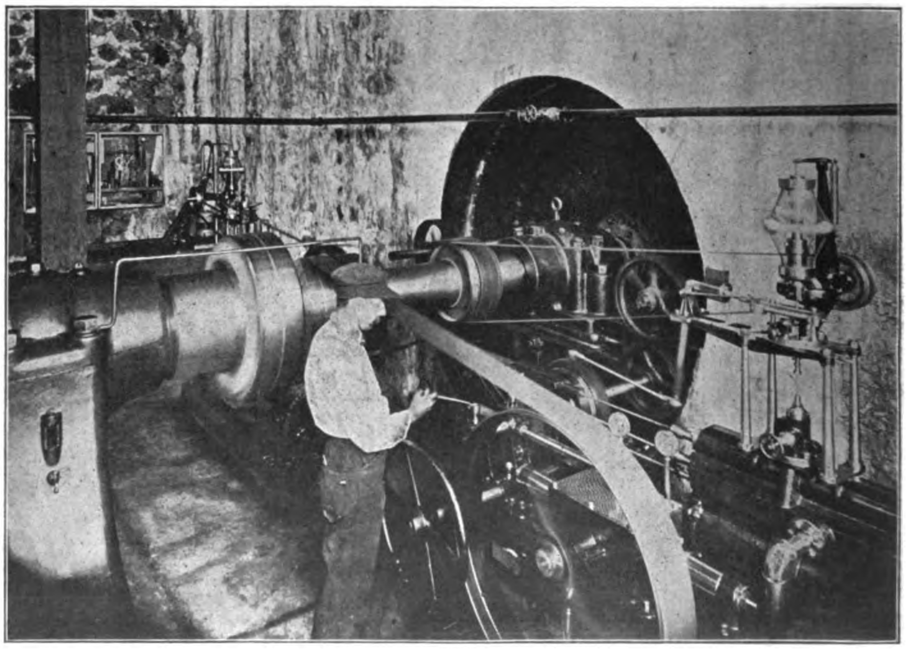


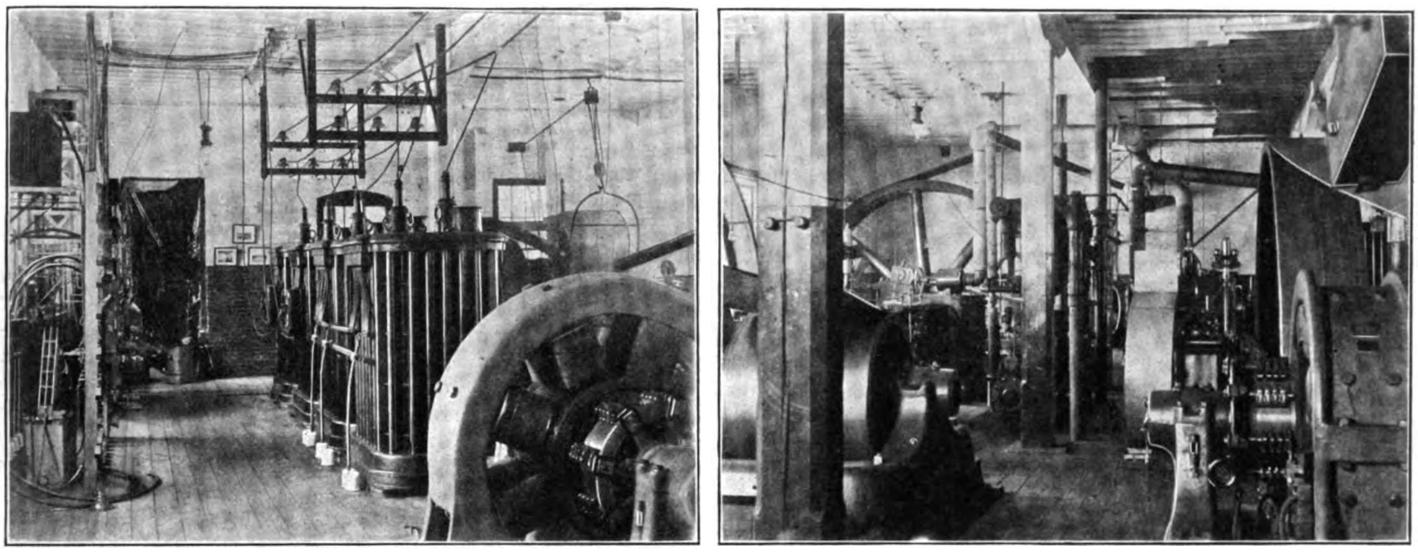
FIG. 4.—THE WATER-WHEEL REGULATORS.

There are two high-tension three-phase circuits to Kalamazoo and one to Allegan; the Kalamazoo lines are transposed through one complete spiral. From Kalamazoo to Battle Creek there is one circuit, with one complete spiral. The first line put in from the power house to Kalamazoo was galvanized iron wire, No. 4 Birmingham gauge. Later, when the load had increased, another line was put up of aluminum cable having a conductivity equal to No. 4 B. & S. copper. The shortest distance between two wires is 42 ins. The poles are 35 to 40 ft. in height and the line runs along the country road. All trees likely to interfere with the line were purchased and cut down. The cross-arms are 10 ft. long, of 3¾ x 4¾ ins. section. The pins are 15 ins. long and hold the insulators 7 ins. above the cross-arms. The insulators are the Provo No. 1 type made by the Hemingray Glass Company, of Covington, Ky. The telephone line is 7 ft. below the transmission line and is transposed at every fifth pole.

It is important to note that although lightning has been so severe that it has splintered poles along the line, none of the transformers has suffered. At the power-house and sub-stations General Electric lightning arresters are used which interpose 34 gaps between the line and the ground. Very little trouble has been experienced from interruptions on the transmission line. A few boys have been prosecuted for breaking insulators.

The sub-station at Allegan distributes current for street arc lighting. It contains one 125-kw. step-down transformer which reduces the voltage from 25,000 to 2300, and two 25-light General Electric constant-current ("tub") transformers for supplying series alternating-current arc lamps. The Otsego sub-station furnishes both commercial and street arc lights and has the same equipment as the Allegan sub-station.

The Kalamazoo sub-station apparatus is in the steam-equipped electric light station which formerly did the lighting of Kalamazoo. The steam plant is still kept in running condition as a partial reserve. A small addition was built on one end of the station building to accommodate the high-tension switches. The transforming apparatus at this sub-station consists of three 250-kw. step-down transformers for 2300-volt constant-potential distribution and three 250-kw. transformers for supplying 550-volt rotary converters. There are two 300-kw. rotaries; one supplies the company's 500-volt power circuit and the other delivers current to the electric railway lines of the Michigan Traction Company. The steam plant comprises two Lane & Bodley Corliss condensing engines with Dean jet condensers, belted to a line-shaft which is belted to a 250-kw. alternator; also a Lane & Bodley non-condensing Corliss engine arranged to drive four Thomson-Houston D-62 railway generators. The boiler plant contains one Heine water-tube boiler rated at 375 horse-power and five 80-h.p. horizontal tubular boilers, with Stilwell-Bierce & Smith-Vaile heaters. Figs. 5 and 6 are views in this station.



FIGS. 5 AND 6.—TWO VIEWS IN THE SUB-STATION AT KALAMAZOO.

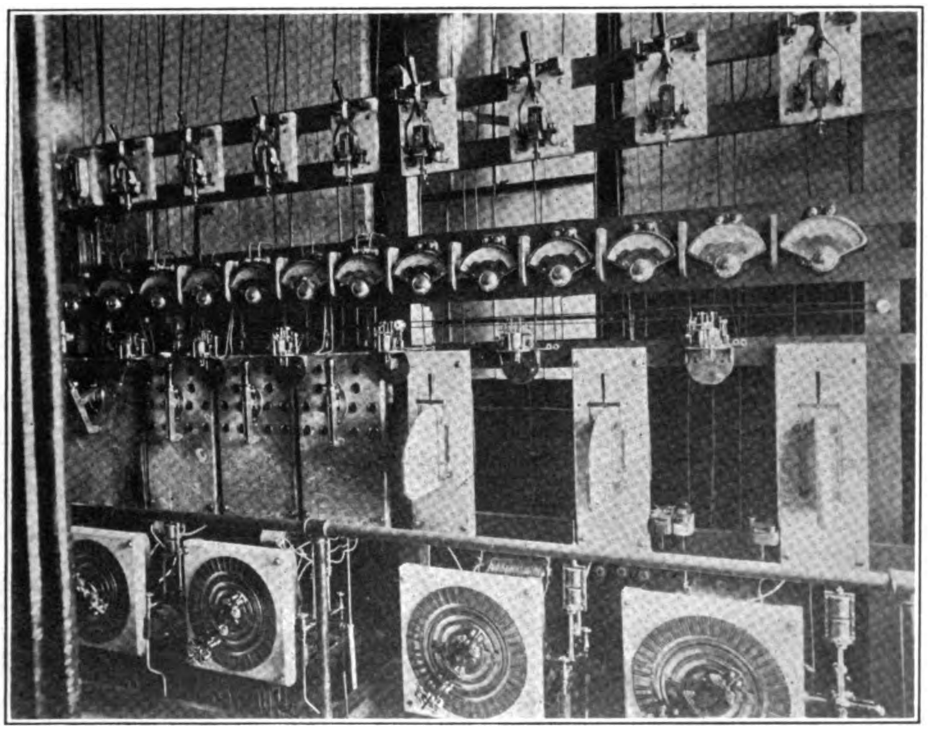


FIG. 7.—SWITCHBOARD IN THE KALAMAZOO SUB-STATION.

In the high-tension switch room the circuits are controlled by long-break knife switches, opened with a hook on the end of a long pole. The lighting circuits are all run out single phase from the sub-station. The voltage on these lines is regulated automatically, independently of the fluctuations in the supply, by an automatic regulator designed by Mr. James B. Foote, the electrical engineer of the company. These regulators are mounted on the single-phase switchboard, as shown in Fig. 7, and are very ingenious devices. The relays shown in the engraving have their armatures so balanced that any rise of voltage above the normal or drop of voltage below the normal makes a contact, closing the circuit through one of the solenoids of the electro-magnetic valve controller shown at the lower part of the switchboard just at the right of each regular dial. The valve operated by the solenoids controls the admission and release ports of a cylinder, the piston of which is geared to the shaft of the regulator; the cylinder is supplied with oil under pressure by a Lombard governor pump. The practical results obtained with this regulator are excellent, and the distribution voltage is held constant in spite of the fluctuations in the supply voltage due to the railway load. The regulator arm operates to cut in or out the coils of a boosting transformer; an ordinary "Type H" transformer was rewound for this purpose. These transformers are located just behind the regulator dials.

The lighting of the downtown district is supplied by three 100-kw. transformers hung on poles and feeding into a three-wire secondary distribution system. The rotary converters are equipped with a device to cause end play and distribute the brush wear. This device consists of a solenoid in the journal box which pulls the armature shaft over and is energized at intervals by means of a solenoid and plunger connected to a dash-pot and carrying a pair of carbon contacts. The journal of one of the rotaries with the wires leading to the solenoid is shown in Fig. 6.

The sub-station at Augusta has three 225-kw. water-cooled transformers supplied with cooling water by a pump gear-driven by a 1-h.p. General Electric motor. The transformers have two secondary windings, one for supplying a 550-volt 300-kw. rotary converter and one for the 2300-volt lighting distribution. The converter delivers current to the Michigan Traction Company's system. Both Galesburg and Augusta are lighted from this sub-station.

The Battle Creek sub-station is much like that at Kalamazoo except that both lighting circuits and rotaries are supplied from the same transformers, as at Augusta. The current here is metered to the local electric light company. All of the transforming apparatus and rotary converters operated by the company are of General Electric manufacture.

The officers of the Kalamazoo Valley Electric Company are Jackson men who are interested in other large projects in Michigan. Mr. James B. Foote is the treasurer and electrical engineer of the company and Mr. H. C. Hoagland is superintendent.

Modern Arc Lighting Practice.

PHOTOMETRIC VALUES OF ARC LAMPS.

BY C. P. MATTHEWS.

Curves of the distribution of light rays about an electric arc, or any other source, are obtained by what may be called the step-by-step method; that is to say, mirrors are moved stepwise about the source of light until the complete distribution of intensity in a vertical plane has been obtained. In each position of the mirrors it is necessary to take from fifteen to twenty-five settings in order to get a good mean. To secure these settings, to make the subsequent calculations, and finally to plot and integrate the necessary curves for a single lamp, require the best part of a day. Now, a test upon enclosed-arc carbons, to be in any degree representative, must combine the result of measurements made upon a number of samples from each brand. Such measurements should be made at intervals of ten hours, say, throughout the life of the carbons. It becomes at once evident that to apply the stepwise method to an undertaking of this kind would be a well-nigh endless task. I therefore set out to develop and install an apparatus which should give at each photometer setting a value of either the mean spherical or mean hemispherical intensity, as might be desired.

The difficulties encountered in the perfection of this method were frequent and oftentimes annoying. When the sources of error were finally taken care of, all the constants determined and the method in successful operation, more than half the available time for testing had elapsed. Notwithstanding this, the total time required by the present method is less than would be required by the old step-by-step plan, and one has the satisfaction of knowing that the apparatus is now in working order for expediting further work in arc-light photometry.

Consider a source, A, Fig. 1, to be surrounded by an imaginary sphere, S, S. Further, let this sphere be divided into narrow lateral zones such as z and z' of equal width. The zone z will be illuminated by rays of intensity I, and the zone z' will be illuminated by rays of intensity I'. Clearly, the rays of intensity, I' in contributing to the illumination of the sphere have greater value than the rays of intensity I in the ratio of the areas of the zones z' and z. But the areas of these zones are to each other as the sines of the corresponding angles marked Θ. We can therefore get a measure of the mean spherical intensity—a quantity that is proportional to the total light output of the source—by reducing each ray of intensity, I, in the ratio of the sine of its inclination to the vertical, and by conveying these rays through the agency of a suitable system of mirrors to the photometer screen. Under these conditions, each photometer setting yields a value of a quantity which, by the

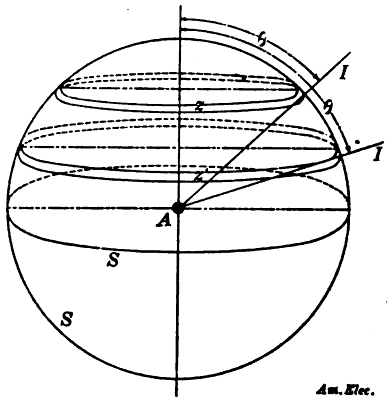


FIG. 1.—SPHERICAL DISTRIBUTION.

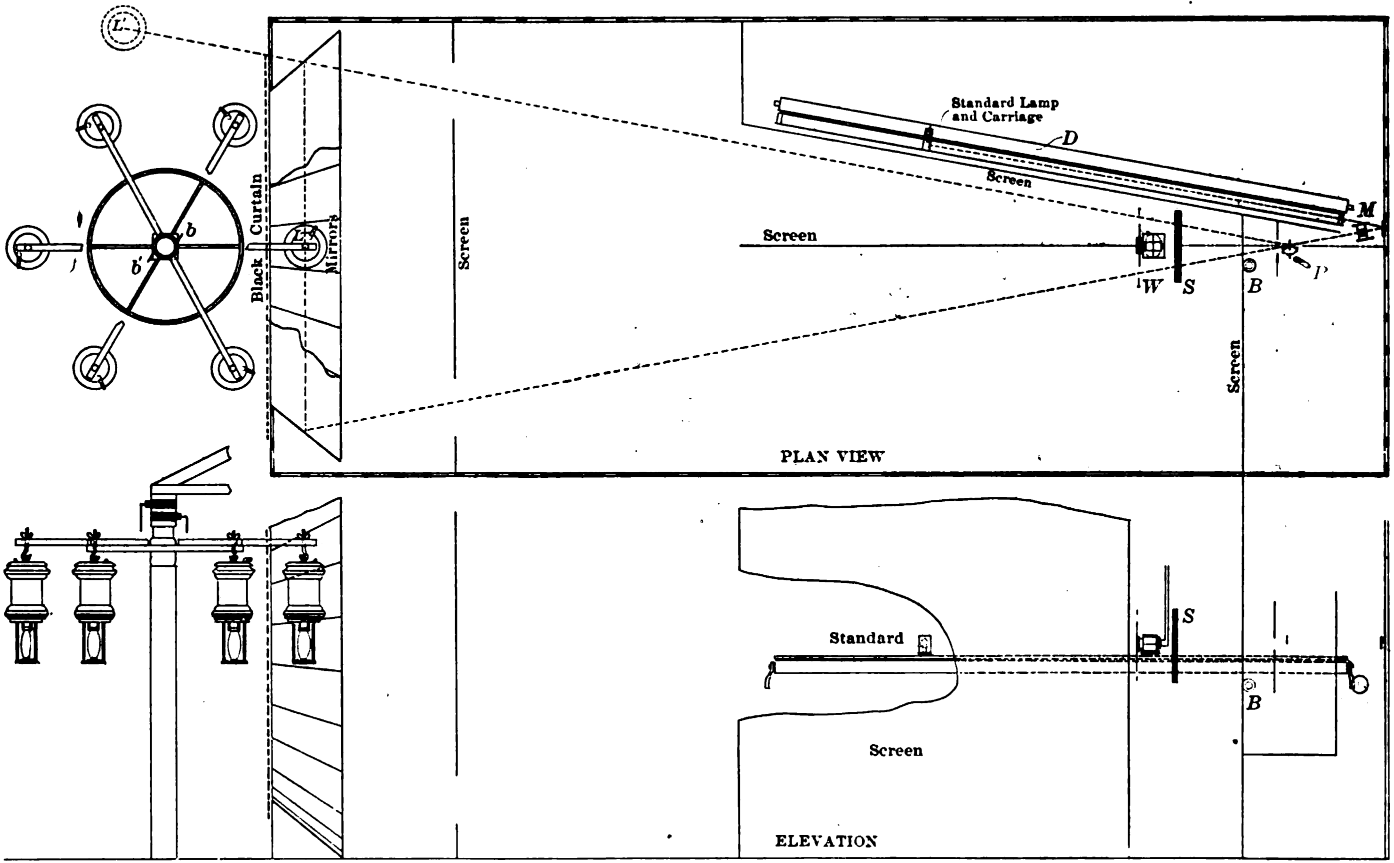


FIG. 2.—PLAN AND ELEVATION OF PHOTOMETER ROOM.

stepwise method, is obtained only after several hours of observation and calculation. It is only necessary to take a sufficient number of settings to eliminate the effects of the wandering of the arc, and the changes in the arc length due to action of the mechanism. Ten minutes suffice for a complete test.

Fig. 2 shows the disposition of the apparatus. Here the lamp, *L*, is in position for testing. The photometer is located at *P*, and the temporary standard is mounted on a carriage under control of the operator at *P* through the aid of a small windlass. All settings were recorded on a suitable drum, *D*, by an electromagnetic device controlled by the observer through the push-botton, *B*. This enables one to continue the tests without interruption, while the autographic record greatly lessens the liability of error and precludes personal bias.

The working standard is an incandescent lamp of the straight filament type, enclosed in a metal box provided with a suitable opening. Into this opening strips with standardized slits can be introduced, thus giving a wide range to the working standard, and insuring that the attempt to measure weak illumination shall not carry the working standard beyond the limits of the photometer bar. Anyone who has worked with a fixed photometer and a movable standard will appreciate the necessity of such a precaution. The temporary or working standard is checked at frequent intervals against a carefully standardized incandescent lamp known as the "reserve" standard. To prevent deterioration, this latter is allowed to burn but a few minutes at a time.

A feature of the apparatus which is of great convenience is the support for the lamps. As shown in Fig. 2, this consists of a wheel with six radial arms, mounted so as to turn in a horizontal plane. Six lamps may be suspended from the arms, provision being made to adjust the height of each lamp accurately by a suitable turnbuckle. To test a lamp at any period of its life it is only necessary to turn the wheel until the lamp is thrown into its proper position with reference to the mirror system. After closing the black curtains behind the mirrors, so as to cut out all extraneous light, the operator proceeds with the measurements. These finished, another lamp is turned into place and the operations repeated. Thus, during the one hundred or more hours of the carbon life, the lamps burn quite unmolested. They are tested as often as may be desired, and always in the same position with respect to the photometric system. A special switch enables one to insert an ammeter and wattmeter in any lamp circuit without extinguishing the light.

PRELIMINARY TEST.

In order to ascertain the behavior of the apparatus on an actual life test, several preliminary runs were made. Two of the most characteristic of these are selected for presentation here. A 110-volt, constant-potential, alternating-current arc lamp, with shade and opalescent inner globe (being, in fact, one of the lamps used in the subsequent tests), was tested at intervals of about ten hours during its life. The results obtained are given in Table I.

TABLE I.

Test.	Time.	Mean Hemispherical Intensity. Hefner Units.	Mean Hemispherical Intensity. Candle Power.
1	2.6 Hours.	273	240
2	12.8 "	249	219
3	22.1 "	237	209
4	33.5 "	236	208
5	45.5 "	251	221
6	56.1 "	233	205
7	66.8 "	233	205
8	76.9 "	200	176

The first point was discarded because of uncertain conditions, but otherwise a curve plotted from these readings is fairly indicative of the behavior of such a lamp. In a life test like this we have probably many minor influences that cannot be taken into consideration, but undoubtedly the prime causes for the observed changes in intensity are the descent of the arc, and the formation of a globe coating. These influences are, much of the time, opposing ones. The resultant effect will be modified according to the predominance of one or the other influence.

An inspection of the inner globes showed that the coating forms most heavily in two regions. Near the top of the globe is a zone of cream-colored ash, quite free from carbon dust. This zone follows the arc in its downward course, but always with a diminishing thickness of the deposit. While there may be a considerable loss of light because of this formation, the increasing available light flux due to the descending arc may oftentimes overcome it, especially in the case of alternating lamps with wide, dark surfaces above the globe. Near the bottom of the globe is a zone of ash lighter in color than that at the top. Mixed with this ash is a considerable amount of carbon dust. The amount of this dust is dependent upon the steadiness of operation of the lamp. If the lamp feeds frequently, or if the carbons chatter, this deposit will be found heavier than usual.

TABLE II.

Test.	Time.	Mean Spherical Intensity. Hefner Units.	Mean Spherical Intensity. Candle Power.
1	5.2 Hours.	140	123
2	16.3 "	130	114
3	23.3 "	120	106
4	33.6 "	118	104
5	44.9 "	123	108
6	55.7 "	123	108
7	66.6 "	125	110
8	76.8 "	107	94
9	87.1 "	114	100

In Table II are given the results of a secondary preliminary run. This lamp was of the same type as that just mentioned, except that the shade was replaced by an opal spherical globe. The globe itself is the chief source of light, and the position of the arc in it has only a secondary effect. The downward trend of these readings must be due to the coating.

TESTS OF COMMERCIAL BRANDS OF CARBONS.

The preliminary measurements just described indicated that the photometric apparatus would adequately answer the purpose for which it was designed. Tests were therefore made with samples of five brands of carbons for enclosed-arc lighting, these brands being well known and obtainable in the open markets of to-day. The carbons were burned in six 110-volt alternating-current lamps, provided with opalescent inner globes and shades. Of these lamps five were fitted with the particular brand of carbons to be tested, the sixth lamp being held in reserve, lest accident or poor operation should require a substitution. The lamps were suspended from the radial arms of the wheel shown in the foregoing plan of the apparatus. With few exceptions the only stops were at the close of the laboratory day. Counting all interruptions, the average run was about eight hours. Not infrequently, a steady run of twelve hours occurred. These conditions are probably somewhat better, and certainly no worse, than the average conditions of practice. The carbon life shown in the following results seems to corroborate this statement, as the life usually claimed for lamps of this type is eighty to one hundred hours. It may be well to note just here that the duration of burning in these lamps is limited by the allowable range of descent of the upper carbon holder. This range is a fixed quantity.

TABLE III.

Carbons:	I.	II.	III.	IV.	V.
Total consumption, inches	6.19	6.3	6.16	6.3	6.32
Clearance	.0094	.010	.0093	.0079	.0151
Extinctions	11	14	16	14	11
Average run	9.3	7.4	7.09	7.3	7.74
Life on one trim	100.1	98.8	115.6	105.2	85.6
Luminous intensity, H. U	202	218	222	259	196
H. U. hours	20,200	21,500	25,200	27,500	16,600
H. U. hours per inch	3,263	3,540	4,089	4,360	2,609

Fig. 3 shows the mean results of the tests. Each curve is the mean of all the curves plotted from the tests of the carbons indicated by the Roman numerals. Carbons II and IV were of European make and carbons I, III and V were American. In every case the upper carbon was cored and the lower one solid.

It is of interest to note that, after 75 hours' burning, carbons I, II, III and V gave approximately the same luminous intensity, and also that the trend of all the curves is, in the main, upward. Carbons IV maintain a distinct lead throughout their life.

A partial summary of the results is given in Table III.

Owing to the growing importance of series arcs of the enclosed type, it has seemed very desirable to make a sufficient number of tests of both the direct-current and alternating-current lamps to get a measure of their relative worth. Table IV contains the data of a test made on a direct-current series enclosed-arc lamp, with an opalescent inner globe and a clear outer; Fig. 4 is the curve of distribution in a vertical plane. Similarly, Table V and Fig. 5 give the results of a test on an alternating-current series enclosed-arc lamp, equipped with an opalescent inner globe and a metallic shade —no outer globe.

TABLE IV.—TEST OF DIRECT-CURRENT SERIES ENCLOSED-ARC LAMPS; CLEAR OUTER, OPALESCENT INNER GLOBES.

E. M. F.	70 volts
Current	6.8 amperes
Watts	476
Mean hemispherical intensity,	329 H. U., 289 C. P.
Mean spherical intensity	266 H. U., 234 C. P.
Watts per mean spherical unit,	H. U., 178; C. P., 202
Watts per mean hemispherical unit,	H. U., 141; C. P., 1.6

TABLE V.—TEST OF ALTERNATING-CURRENT SERIES ENCLOSED ARC LAMPS; OPALESCENT INNER GLOBE AND METALLIC SHADE.

E. M. F.	70 volts
Current	6.6 amperes
Apparent watts	462
True watts	397
Power factor	.86
Mean hemispherical intensity,	314 H. U.; 276 C. P.
Watts per mean hemispherical unit	H. U. 126; C. P. 1.43

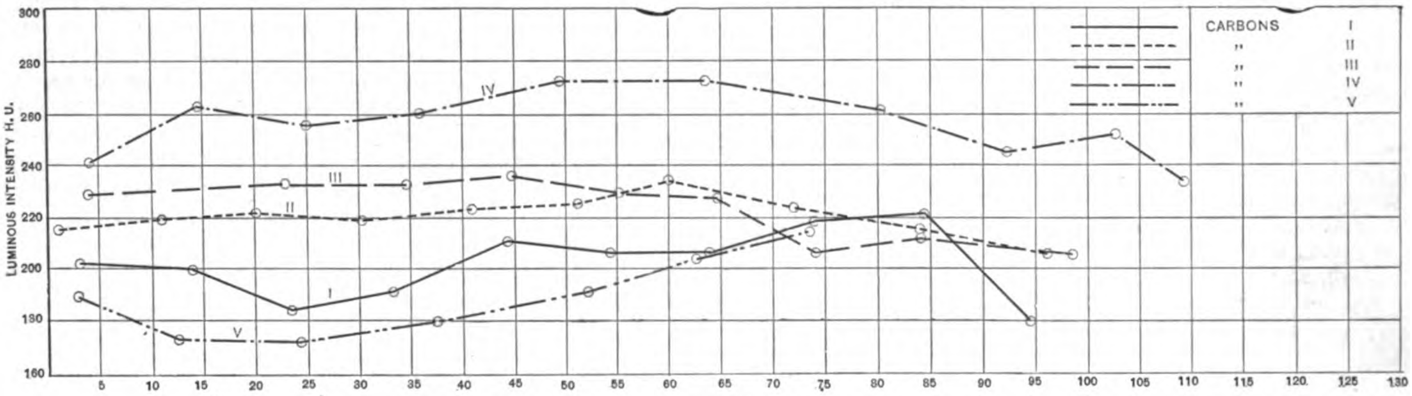


FIG. 3.—RESULTANT CURVES SHOWING AVERAGE PERFORMANCE OF COMMERCIAL CARBONS.

As producers of light below the horizontal, the two lamps equipped in the manner stated are about equally efficient, but the direct-current lamp would, of course, be considerably superior if fitted with a shade instead of a clear outer globe.

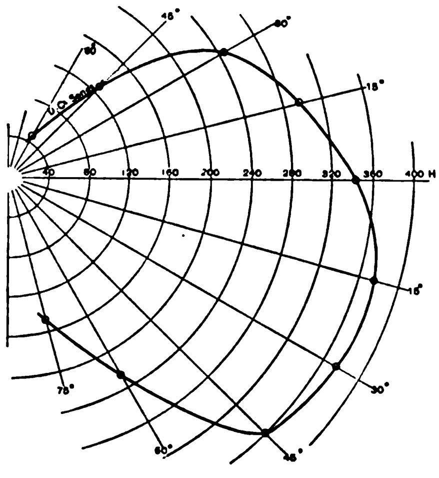


FIG. 4.—DISTRIBUTION FROM DIRECT-CURRENT ARC.

[The foregoing is an abstract of Prof. Matthews' report presented at the convention of the National Electric Light Association recently held at Niagara Falls.]

◆

ARC LIGHTING AT THE BEGINNING OF THE TWENTIETH CENTURY.

BY W. H. HILLMAN.

At the convention held by the National Electric Light Association two years ago in New York City, Mr. H. M. Atkinson, President of the Georgia Electric Light Company, Atlanta, read a paper entitled "Alternating-Current Generation and Distribution." In concluding his paper, Mr. Atkinson asked three questions, one of which was:

Assuming alternating current to be the source of supply, will the arc lighting of the future be accomplished with direct-current arc machines driven from alternating-current motors, or with series alternating-current lamps operated from constant-current transformers?

Particular attention is called to this point, because two years have intervened, and at the present writing the lamps which are illuminating the streets of Atlanta are series alternating enclosed arcs, operating from constant-current transformers.

At the convention two years ago, the question was asked, "Are we to-day able to state it as an accomplished fact that arc lighting for street service may be equally as well obtained by the two forms of current, i. e., alternating and direct?" At this discussion, definite conclusions were not reached; it may, therefore, be of interest if further evidence is offered, substantiating the claim that arc lighting for street service may be equally as well accomplished by either alternating or direct-current.

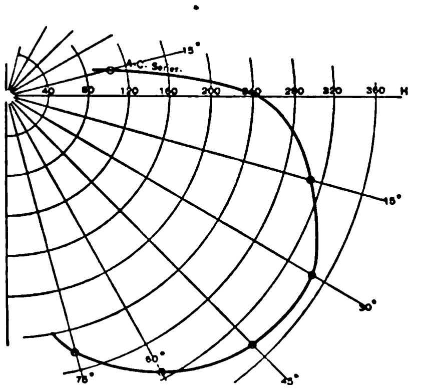


FIG. 5.—DISTRIBUTION FROM ALTERNATING-CURRENT ARC.

For six months the Monongahela Light & Power Company has been operating one thousand alternating-current enclosed-arc lamps in the suburbs of Pittsburg. They replaced 9.6 ampere open-arc lamps and speak only words of praise in regard to the satisfactory service secured. Effective illumination is secured, which is satisfactory to the city authorities. The system is also satisfactory to the company which furnishes the light. Fourteen 100-light transformers and one thousand series alternating enclosed lamps complete this arc lighting equipment. Part of the system is operated on 6000-volt primaries, and part on 2200-volt; some of the transformers are in the main station and others in sub-stations. Surely, such installations are of a representative character, and in addition to further evidence referred to later, would indicate that we have reached the conclusion that alternating-current is as good as direct for street arc lighting.

Since the convention two years ago, 50,000 enclosed-arc lamps have been installed for street lighting, of which 30,000 lamps are alternating-current. Enclosed arcs have been adopted by 350 cities, of which 300 have introduced alternating-current arcs. About 270 cities are operating 6.6-ampere lamps, consuming only 430 watts (average), as compared with about 30 of 7.5 ampere, consuming 485 watts (average). Attention is particularly called to this latter point, because it shows that as far as volume of light is concerned, the alternating system has fully met the demand. In fact, while the 7.5-ampere, 485-watt lamp has been available since the system was first introduced, 90 per cent of the cities and towns have adopted the lower energy lamps, consuming only 430 watts. If the limiting feature of the system has been in respect to the volume of light from an alternating lamp, surely the 7.5-ampere system would have been adopted exclusively.

Since alternating-current arc lamps came into use, the subject of power factor has frequently been raised, and resulted in lengthy discussions. The multiple type lamp met such a long-felt want that since its first introduction it has been popular, notwithstanding that it has had a power factor of only .68 to .70. The alternating-current street lighting system has been before central station people only about two or three years. From the start, it was thoroughly appreciated that the prejudices existing against an alternating arc lamp necessitated that such a system must be absolutely satisfactory in operation to suggest even a partial success. It was the distinct purpose of the engineer to introduce such an amount of reactance in the system as would at all times effect steady and reliable operation. The series coils introduce a lagging current in the lamp which lowers the power factor, but at the same time produces a reliable lamp. The system complete has a sufficient amount of reactance and the result is a hardy and substantial arc lighting service.

A multiple direct-current lamp improperly adjusted so that an insufficient amount of resistance has been connected into the circuit, will pound and chatter, and furnish an interrupted service. The trouble, however, is confined to that particular lamp. A multiple alternating lamp, having the reactive coil improperly adjusted so that there is too much or too little inductance in circuit, will produce poor results, but here also the trouble is confined to the individual lamp.

A series system designed with insufficient reactance will cause the regulator coils to pump; trouble ensues immediately. This trouble not only affects one lamp, but it extends over the entire series. It not only affects the arc lighting but extends to the incandescent service. The secondary circuit may vary in potential from 95 to 120, and the incandescent service has been made seriously unsatisfactory because of insufficient reactance in the arc lighting system. First-class, reliable service is the first essential. A difference of 10 per cent in power factor demands only a slightly increased investment, while the actual cost of operating is practically the same.

So much has been said of late years in respect to insulation of multiple transformers that central stations have readily appreciated the necessity of insulating the arc lighting system thoroughly from the main distributing system. Where a reactive coil system is under consideration for street lighting, it is recommended that a constant potential transformer be installed between the generator and the arc lighting regulator. If this is not done, any ground on any one of the arc lighting circuits will ground the entire system.

Many schemes have been considered in connection with street lighting from the alternating-current system. Frequently the argument is presented that multiple alternating lamps can be used with practically the same degree of economy and convenience as the series alternating system. Where the wires from the old arc systems were strung out from the station in pairs, instead of a loop, there would be a greater tendency to consider an installation of the multiple lamp. The question would naturally arise as to whether they would be installed on the constant potential transformers which were used for commercial and residence lighting; if so, the lamps would have to be controlled individually, necessitating switching them off and on by an attendant, or collectively by means of some magnetic switch. The first method would be expensive, and lamps would not be lighted simultaneously. The second method would require special additional wiring. At the present writing, street lighting by multiple alternating lamps has been considered only in isolated cases. The idea does not seem to have special merit.

Another method which has been suggested might be illustrated in connection with a 500-light system. A large constant potential transformer installed at the station is arranged with loops brought out on the secondary side to accommodate ten 50-light circuits; each circuit having a reactive coil installed as a regulator for series alternating lamps. One objection to this arrangement would be that should any accident happen to this transformer, the entire arc lighting system is put out of service. If an attempt is made to avoid this point by using two or three smaller size transformers, the system becomes complicated and the attempt to secure high efficiency together with low cost is defeated. It is, therefore, a fair statement that the most practical, economical and all-around satisfactory system is the series alternating arc system, operated with constant-current transformers.

The fact that the direct-current systems of street lighting have not been referred to freely in this paper is not due to any lack of appreciation for these systems of arc lighting. As the century opens, it sees the interior and outside lamps for arc lighting fully met with well tried and thoroughly reliable systems: the multiple enclosed lamps for interior lighting; the series enclosed arcs for street lighting. Large sized arc machines are successfully used, operating as many as 175 arc lamps. Approximately 50 cities and towns have adopted this method of street lighting, and wherever the direct-current light is used there is no question about the quality of illumination. No change from open to enclosed arc lamps has reflected greater credit upon central station management than that which took place at Boston, and it was not long before a great many large and representative stations, throughout New England especially, were equipped with direct-current enclosed arcs, strengthening their position in respect to the street lighting business. We therefore find to-day upward of 20,000 direct-current enclosed arcs installed for street lighting, of which 15,000 are 480-watt lamps, requiring 6.6 amperes, and 5000 are 350-watt lamps, requiring 5 amperes.

[The foregoing is an abstract of a paper read before the recent convention of the National Electric Light Association, held at Niagara Falls, N. Y.]

THE CENTRAL STATION BOILER ROOM.

BY WILLIAM D. ENNIS, M. E.

The assertion is on record that electrical engineering is 90 per cent mechanical. It is not on record, but is none the less true, that central station engineering is largely steam engineering. When a young man enters an electrical plant as assistant to the superintendent or engineer he is apt to find very little use for his mathematical knowledge of alternating currents, and a great demand for familiarity with the prosaic details of the boiler room. The electrical apparatus, including generators, motors, transformers and conductors, is all of high efficiency as compared with that of the engines, pumps and furnaces. A good generator will operate throughout its entire existence at an efficiency of perhaps 85 or 90 per cent; while the output of a steam plant seems microscopic in proportion to its coal consumption. Not only are the losses in the steam end of the plant greater, but they are more variable, more uncertain and more difficult to detect.

One of the first things to be studied is the fuel. The price alone does not determine which is the cheapest fuel. The ash produced in firing under usual conditions furnishes a fairly good measure of the waste of the coal; but this is not an infallible test. The grates, the distance between grates and boiler shell, the rate of combustion, the method of firing, the amount of air supply, or the intensity of draft, may not be suitable for the coal; in which case the fault is not with the fuel but with the equipment and the operatives. After the question of quality has been settled for the particular plant in operation, the price can be looked into. A point that should not be overlooked is the fact that while an inferior grade of coal may be cheaper at the mine, the cost of hauling and handling is practically the same as that for the best coal; which would indicate that as a general rule high-class coal is more economical even at a higher price.

The fuel should be accounted for and the stock as carefully balanced from time to time as would be the stock of goods on hand in a warehouse; a daily record of cars received and of quantity on hand at a given hour should be maintained. The division of the storage space into several small compartments will facilitate accuracy in this accounting. The weight per cubic foot of coal containing an average proportion of moisture can be readily ascertained for each particular size, and the bins or compartments may be marked at suitable heights to indicate a specific number of tons when leveled down. The daily consumption of fuel should be recorded as accurately as possible; preferably by actual weighing. The coal can be hauled from the bins to the boilers in a barrow or car of known weight, over a floor scale on which the balance is fixed. A few scoopfuls thrown on or off will suffice to balance the scale weight, and all that is demanded of the intelligence of the wheeler is the ability to make a chalk mark on the wall for each load. The stock should be allowed to run low three or four times each month so that the daily consumption can be checked and corrected to correspond with monthly stock taking and accounts of cars received.

The handling and hauling away of ashes frequently involve a large amount of labor that can be saved with proper facilities. The pits should be of such construction as to permit of quick and thorough removal, if conveyors are out of the question. In some cases a market can be found for the cinders and the cost of handling eliminated; any income in this direction should be credited to the fuel cost.

The other prime raw material of consumption in the boiler house is water. This may be free and still be a source of expense. Water from a running stream is apt to cause trouble with the suction lines unless a well is built, located out of the current. Most streams carry in suspension a considerable quantity of sediment that must be released in settling tanks if it is desired to avoid complications in the boilers. The question of scale must be considered, and the water analyzed to ascertain the percentage of scale-forming ingredients. The sample of water must be such as to indicate average conditions, which are subject to variation with the season of the year, the depth and the velocity of flow. If water is purchased from a town supply and paid for by meter rates, it may be profitable to operate a surface condensing system and return the condensation to the boilers; but this involves an element of danger in offering an opportunity for cylinder oil to reach the heating surfaces. The town supply being ordinarily under considerable pressure, the work of a feed pump may be decreased or even made unnecessary by its use.

Water supply must, of course, be measured in order that there may be a record of the performance of various grades of coal, as well as of the evaporation performed by the boilers. The most thorough method of measurement, as well as the simplest, is by means of tanks into which a known quantity of water is delivered for the pump supply. Where conditions require surge or settling tanks, these may be used for metering, and a little ingenuity will reduce to a minimum the amount of attention required to keep count. In a small plant, or in one where surge tanks are unnecessary, it may not be advisable to go to the expense of providing tanks for metering only. In such cases, a water meter is the next best thing. Operated intelligently, it will give reasonably accurate records, and it is desirable to install a meter in any instance to furnish a check upon the tank records.

All figures of boiler economy or coal efficiency should be reduced to equivalent evaporation from and at 212° Fahr., and, if possible, corrected for quality of steam. In any plant the power department embraces all operations from the coal pile to the various machines. An accurate coal and water record will assist the engineer to subdivide the operations into three groups, including, respectively, steam generation, power development and power transformation. The first group includes the work of the furnace and boiler with their auxiliaries; the second, that of piping, steam engines and condensers; the third, that of shafting, drives, electric generators and motors.

Starting with coal and water as the raw materials of steam generation, the first step in their utilization is in the furnace. Usually, in speaking of a boiler the furnace is included. In practice it is difficult or impossible to make a test which shall separate the two and demonstrate the economy of each. What is known as a "boiler test" is in reality a test of the boiler and furnace combined. The two elements can be separated, however, to the extent of determining where the losses are in any given plant. Incomplete combustion of coal, or low furnace efficiency, is indicated by a high temperature of flue gases, black smoke, and unburned coal in the ashes. These effects may be caused by an excess of draft, insufficient or unheated air supply, or infrequent and heavy firing; all of which may be due either to the carelessness of the fireman, or to features of furnace design or a necessity for overdriving. The best economy is obtained when the flue gases enter the stack at a temperature of about 525° Fahr., when no smoke is produced (the disengaged carbon being consumed in a bright white flame at the back of the boiler) when the grate bars are of proper spacing and opening and when each bed of coal is thoroughly burned up before dropping or shaking into the ash pit.

Low efficiency in boilers is due to improperly arranged heating surfaces (preventing the infringement of hot gases on the sheets), leaks between the furnace and the smokebox, foulness of heating surfaces, defective circulation of water, lack of provision for taking steam from the highest point and radiation of heat.

Aside from these factors, which depend largely upon the initial design of the boiler and surroundings, and are frequently not in the control of the attendant, there is room for the exercise of economy in the method of operation. There is some difference of opinion as to the most economical rate of evaporation in horizontal tubular boilers. Tests made by the writer showed a gradual increase in efficiency with increase in evaporation per square foot of heating surface. Recent experiments with a plant in which the boilers were being driven at 25 per cent overload showed that throwing off one boiler increases the economy of fuel. It is difficult to lay down any fixed rule as to the number of pounds of water that should be evaporated per hour per square foot of heating surface, owing to differences in furnace construction, in fuel and in the method of firing. As far as the boiler itself is concerned, as a separate apparatus from the furnace, the higher the rate of evaporation the better. The limiting factor in the furnace proper depends upon the point at which incomplete combustion and a high temperature of flue gases become manifest. For every plant, and for every grade of fuel used, the most economical rate of evaporation should be ascertained by careful test, and adhered to as closely as possible in practice. Operate a sufficient number of boilers so that each shall be making that quantity of steam which it can produce to best advantage.

In connection with the foregoing dictum there is another point which may be mentioned as desirable where it does not conflict with local municipal regulations. The load on a power station may be extremely variable. The storage battery is sometimes installed as an electrical flywheel to minimize the effect of this variation. In the boiler room, the only storage possible is that of hot water. If an economizer is in use, it will fully answer this purpose. If not, a simple and effective arrangement is to pipe the feed pumps and injector so that they can take their supply from a dead boiler and deliver it to one under steam. Thus, if at midnight one boiler is cut off, at 4 a.m. it may be cool, and the large amount of water near the boiling point which it contains may be pumped over to one of the other units, saving a large proportion of the heat originally imparted to the water. This system may also be of value as providing a temporary reserve supply of water in case of failure of the main supply when the plant is under other than its maximum load.

Of more than secondary importance is the steam and water piping of the boiler room. This may either be an essential feature of high economy or a source of never-ending annoyance and loss. It is only recently that the subject has been given adequate attention, and the piping is yet the weak point of many otherwise economical plants. For high and low-pressure steam and water, pipe lengths should be bent to long radius rather than united by cast-iron elbows. The stop valves should be straightway gates of the highest class made. For steam pressures above 100 lbs. per square inch, extra heavy fittings and valves only should be employed. For pressures above 150 lbs. extra strong pipe is desirable. Cast-iron or galvanized pipe should be used for cold water, brass pipes, valves and fittings for hot water. Screwed joints are simple and give easier construction, but the convenience of flanged fittings and valves renders their use a mark of good practice. Provision should be made for draining off all water of condensation from the steam lines, and also for disposing of it most economically.

The main steam lines should rise from a nozzle separate from that for the safety valve, and should enter the side of the steam drum through a gate valve at the end of a long pipe bend. The header should be dripped at each toe, and the simplest disposition of the drips is to run each one through a stop valve and check valve into the back head of the boiler. There should be a main cut-off valve in the boiler room, located on the main header, so that the plant can be cut off in case of accident in the engine room. Steam connections to fire pumps should be made on the boiler side of this main valve, so that the pumps can be operated from any boiler under steam. Additional cut-off valves should be provided on each pipe entering the boiler room, to be operated in case of a break in the boiler room. It is essential that the main valves over each boiler should be easily accessible from the floor.

All feed-water piping should be fitted with a check valve on each pump discharge and on each boiler connection. The individual branch pipes should be fitted with a valve on each side of the check, the inner one being preferably a globe valve. The best method of connecting the branch pipe to the main line is by means of a Y, nipple and 45° elbow.

The blow-off system will be troublesome unless properly installed. The outlet on the boiler must be exactly on the bottom. The pipe, if screwed in, should not project above the inner surface of the shell. A bent pipe is better than two pieces of pipe joined by an elbow, and this should be protected from the action of the fire by a piece of lap welded casing abutting against the boiler at the top, and extending down below the earth or brick paving of the combustion chamber. The asbestos-packed cock is probably standard for blow-off piping. It frequently gives trouble, however, especially when the water is dirty, and the packing will need attention at least weekly. The different pipes should best be run separately to the blow-off tank or out doors. If they are run into a common main, as is usually the case, the junction should be made with Y, nipple and 45° elbow, as in the case of feed pipes, rather than with a tee. The objection to this is that it increases the number of joints. More difficult to make, but best of all, is a double bend starting from the bottom of the boiler and ending at the Y on the main. This requires careful fitting, and unless there is ample room, prohibits the use of a casing. In some plants, two blow-off valves or cocks are used, one bolted to the other, so that in case of a leak in one, the boiler will still hold water. Blow-off pipes should be regularly inspected, while the boiler is steaming, as they occasionally clog up if not regularly opened, and will then be burned. Where there is a common main, the inner tee can be fitted with a nipple and stop valve, providing an easy method of ascertaining whether any of the cocks leak. Many cases of increased fuel consumption have been traced directly to leaky blow cocks.

The method of boiler feeding is of interest. Where the plant contains an engine or engines that run constantly, and there is no economizer, a power pump driven from the main shaft is most economical to operate. If there is no such engine, or if, instead of an economizer, a small heater receiving the pump exhausts is used, a steam pump is best. If the water is dirty, the outside packed plunger type of pump will cause the least trouble. For hot water, linings, rods and pistons or plungers should be of brass. It is always well to provide two feed pumps, each large enough to feed the entire plant at its maximum economical piston speed. Under normal conditions, both pumps should be used. In case of accident to one, the other can be speeded up temporarily while the first is being repaired. It is usual to install an injector as reserve, even when two pumps are used. The safest provision is to have an entire separate feed-pipe system from the injector to the boilers. Water relief valves do not always operate in time.

In plants containing an economizer, there are certain complications that are bound to accompany the savings effected. The fans and fan engines must be looked after carefully, and some economical disposition made of the exhaust from the latter. In the economizer proper, the scraping gear, engine, soot chamber and regular blowing off must be regularly attended to. The temperature of escaping gases and feed-water should be recorded, the object being to obtain and maintain the maximum amount of benefit from the apparatus. The highest economy is obtained when the chimney is of such design that during periods of light load the fans will not be required. The power necessary to drive fan engines is usually estimated to amount to from 2 to 3 per cent of the total plant capacity; the power to drive the tube-scraping gear of the economizer is negligible.

The small accessories of the boiler plant are worthy of careful attention. Damper regulators, which are now almost universally used, should be connected with good substantial fittings and gearing for operating the damper lever. The pulleys should be kept oiled and the bearings clean. Note should be made of the increase in pressure necessary to fully open the damper, and this increase should be kept low by proper care of the attachments. It is advisable to make sure that the steam gauges register the same for equal pressures. The best gauge is a small one with black figures on a white dial; brass dials render it impossible to see the needle at any distance. Large gauges are usually fitted with such heavy pointers that the mechanism is not powerful enough to move them promptly. The gauges should register the pressure at which the safety valve is set when the latter blows off.

The fireman should be taught not to depend absolutely on the gauge glass for an indication of the water level. The try-cocks should be opened very frequently. Occasionally the gauge glass should be blown out. Five or six inches depth of water over the tubes at the front end of a horizontal tubular boiler is ample, and more may cause the boiler to "prime."

The safety valves should be blown at least every 24 hours to make sure that they do not stick. Except in case of the unexpected stoppage of the main engines, the firemen should never be allowed to raise the pressure sufficiently high to operate the safety valves. It is very often the case that through carelessness or stupidity the outlets of safety valves are turned so as to make them a source of danger to anyone on top of the boilers. This can be obviated by piping them up toward the roof 6 or 7 ft., the pipe being dripped at its base to draw off any water that may stand there.

Recording steam gauges should form a part of every well-ordered plant. They require very little attention beyond keeping the pen cleaned and filled with ink. The valve should be throttled just enough to prevent the index hand from vibrating, and the gauges, damper regulator and valve should all be boxed in and locked, and the key entrusted to the head of the department. Otherwise signs of carelessness that would be indicated by the gauge will be adroitly concealed by some one. The box can be provided with a glass front.

The boiler settings require occasional inspection for signs of leakage or weakness. Settings wear out occasionally and must be completely renewed. The ironwork in the setting will also require some attention. Fronts, fire doors and clean-out doors should fit closely in their frames and the frames in the brickwork.

The essential feature of boiler room, as of all engineering management, is to be resourceful and persistent in securing data, and equally resourceful and persistent in using that data to secure more economical and better results. It is only by taking each phase of the problem and pushing it forward to a solution that the central station engineer can reduce the expense of operating his boiler plant.

Gas Engine Efficiency Tests.—In a paper read at the recent Milwaukee meeting of the American Society of Mechanical Engineers, Mr. C. H. Robinson gave the results of efficiency tests of a 125-h.p. Westinghouse gas engine. The average thermal efficiency of the engine was 20.05, the highest being 23.24 per cent; the figures correspond to 171.66 and 226.13 B. T. U. per indicated horse-power-minute, respectively. The mechanical efficiencies corresponding to these tests were 79.39 and 89.05 per cent, respectively. Tests were made to determine the distribution of heat in the engine. At the lowest horse-power of the series 10 per cent was accounted for by the indicator, 32 per cent went out in the exhaust and 58 per cent in the jacket water. At the highest horse-power (164 indicated) these figures became 26, 44 and 30 per cent, respectively.

Niagara Convention of the National Electric Light Association

FIRST DAY.

The National Electric Light Association held its twenty-fourth annual convention at the International Hotel, Niagara Falls, N. Y., May 21 to 23, inclusive. At 10:45 Tuesday morning President James Blake Cahoon called the convention to order and delivered his presidential address, in the course of which he referred eloquently to the great Falls of Niagara and their industrial utilization. President Cahoon, referring to the trend of electrical development, pointed out that experiments are in progress with a view to commercializing the Nernst lamp, and called attention to the fact that an arc lamp has been brought out in Germany in which rods of refractory oxides, such as thorium, yttrium, zirconium, etc., are used in place of carbon rods, and have an efficiency which is claimed to be about double that of the ordinary carbon arc lamp. He also referred to the vacuum tubes which Mr. Peter Cooper Hewitt exhibited at the Conversazione of the American Institute of Electrical Engineers recently held at Columbia University, New York. The Pan-American Exposition naturally came in for a share of complimentary mention from Mr. Cahoon. At the close of the president's address Mr. Calvin W. Rice of New York read a paper on

"The Transmission of Current at High Potential in New York City."

Mr. Rice's paper consisted of a brief description of the station equipment and distribution system of the New York Gas & Electric Light, Heat & Power Company. Mr. Rice pointed out that the frequency of 25 cycles which has been adopted facilitates the design of the rotary converters employed for changing alternating current to direct current for railway work and distribution over the Edison three-wire network, but does not admit of successful incandescent or arc lighting directly from an alternating-current circuit. The station equipment when completed will consist of 16 vertical three-cylinder compound condensing engines of 5200 horse-power each at maximum efficiency, direct-connected to three-phase alternators of 3500 to 4500 kilowatts capacity each, delivering current at 6600 volts.

The transmission cables are lead-covered three-conductor, each conductor having 250,000 circular mils cross-section. The insulation of about one-half of the cables is rubber and that of the other half paper. The insulation resistance required for the rubber-insulated cable was 100,000 megohms per mile, measured either between the conductors or between each conductor and the lead sheathing. The insulation resistance required for the paper-insulated cables was 400 megohms per mile. Mr. Rice stated that both classes of cable had proven satisfactory. The distribution system, as at present installed, is such that at no point in the system is there more than 5 per cent actual drop in any feeder. The rotary converters used at the sub-stations are six-phase machines, supplied in the usual manner through induction regulators from transformers. Only two sizes of converters are used, 500-kw. and 1000-kw. There was practically no discussion of Mr. Rice's paper.

The next paper read was one by Mr. L. R. Wallis, of Woburn, Mass., on

"The 4-C System of Charging."

The method which Mr. Wallis described consists of making a fixed charge to all customers, grading the rates of fixed charge so that the average will cover the fixed charges of the plant, and then making an additional meter charge for the service actually rendered. This system was fully described by Mr. Ralph J. Patterson in the American Electrician for December, 1900. Mr. Wallis stated that previous to July 1, 1900, the methods of charging which were in vogue in his territory for residential consumers were (1) metered service at 20 cents per kilowatt-hour, and (2) the Wright demand system as an optional plan with an initial charge of 20 cents per kilowatt-hour for the first 480 hours and a secondary and final price of 10 cents per kilowatt-hour. The methods observed with relation to business consumers were (1) a metered service at 10 cents net per kilowatt-hour, (2) a flat contract charge per annum based upon the number of lamps installed, and (3) a flat contract charge per annum based upon the total number of lamps in use and the number of hours per annum. Since July 1, he stated, 100 business consumers, who had previously been purchasing at flat contract rates without meters for several years, have been supplied on the plan described in the paper, with mutually satisfactory results, and all former meter customers have been operating upon a capacity charge fixed by their previous year's consumption, all current being charged at 5 cents per kilowatt-hour with a guarantee that their rate per unit for the present year would not exceed their former rate per unit, and that all current used in excess of that used the previous year would cost 5 cents per net unit. This was used as a temporary plan for changing over from the old systems to the new, and, according to Mr. Wallis, it resulted in the customers using from 10 per cent to 600 per cent more current than was previously used. Mr. Wallis stated that one of the results of the application of the system described had been that instead of carrying the heavy load for about half an hour each day it has extended over a period of three to four hours.

HENRY L. DOHERTY,
President, National Electric Light Association.

President Cahoon having invited a discussion of the paper, Messrs. J. M. Walker of Newcastle, Pa., and E. Slade of Quebec, Canada, suggested that there was too much in the paper to admit of a discussion immediately after hearing it read, and that it would be advisable to have the discussion postponed to a later session in order that those interested might have an opportunity to analyze the contents of the paper. The discussion was therefore deferred until the Wednesday afternoon session, at which time Mr. Slade stated that the similar plan of charging described by Mr. Henry L. Doherty last year had been put into use by his company in Quebec. It was offered as an optional rate and has taken very favorably. The principle trouble Mr. Slade had found was to get a maximum demand cut-out which would limit a customer to the demand he contracted for. Referring to the fixed charge against customers, Mr. Slade did not think that it was allowable to take the full capitalization of the plant as a basis for the fixed charge per lamp, and Mr. Wallis explained that this fixed charge was not based on the total capitalization of the plant but on that portion of the plant which was used for incandescent lighting.

Mr. Slade then stated that in Quebec, at the rates in effect for the last year, his company's average income per metered lamp per year on a straight meter basis was only $1.03; whereas, if they tried to adopt Mr. Wallis' system up there it would bring the cost on the start higher than the cost per lamp on the straight meter system, and would tend to frighten the consumers off. In reply to a question by Mr. Slade, Mr. Wallis explained that his company used a maximum demand cut-off device containing a shunt and series-wound magnet which causes the lights to flicker when the stipulated demand is exceeded, and automatically restores the circuit to a steady condition when the excess in lights is turned off.

Mr. Walker (Newcastle, Pa.) stated that a comparison of the figures given in the paper with those which were in effect in his town showed that up to the point where a customer uses 22 lights the rates according to the paper are higher than those now in force, so that it would be very difficult to put the system into operation in his plant. Mr. Wallis explained that the rates given in his paper were simply those that were in effect in his town and that they were not presented for the purpose of establishing a fixed set of rates for all stations; the object of his paper was merely to present the system and to allow each station to make up its own table of rates. Mr. Walker stated that the reason he compared Mr. Wallis' figures with the rates in vogue at his station was that the paper stated that the average cost of station equipment per horse-power of the high-efficiency direct-connected type was taken at $225, that he supposed that the capacity charge was based on this figure, and that he did not consider that his plant would go under that figure.

Mr. M. E. Turner, of Cleveland, asked Mr. Wallis if he would make any difference in his fixed charges as between alternating-current and direct-current customers, and also if the distances from the station to the customer was taken into consideration. Mr. Wallis replied that he considered the increased line investment in the case of direct-current customers to offset the cost of alternating-current distribution apparatus, and that he did not think the customer's distance from the station should enter into the matter at all, as a common carrier could not discriminate as to location. Mr. Slade asked Mr. Wallis if he found that the customers' bills were materially increased by the adoption of the new system, and Mr. Wallis replied that he had found an increase of consumption which astonished him perhaps as much as it would other members of the association, the increase of consumption by individual customers ranging from 10 per cent to 600 per cent, as is stated in his paper.

Mr. F. E. Smith, of Somerville, Mass., asked how Mr. Wallis' customers as a whole received the system, and pointed out that while some of the customers in changing from the old plan to the new one would be benefited many others would not. Mr. Wallis replied that when the system was first introduced a number of customers did not think it was to their advantage, and he had not supposed that they would do so. Twenty-four of his customers petitioned the Electric Light and Gas Commission for a hearing on the subject, and at the time of the hearing eighteen of the twenty-four were absent, and explained that when they had signed the petition they were not familiar with the plan, and that it had since developed to be satisfactory to them. The man who headed the petition to the Commission, Mr. Wallis stated, had since written to him a personal letter expressing his full approval of the plan.

Mr. Charles B. Price, of New Bedford, Mass., asked what provision Mr. Wallis made for enabling a customer to exceed the normal demand on special occasions, such as an entertainment at a residence when the customer would probably wish to use all of the lights in his house. Mr. Wallis replied that he employed the same method that the Wright demand system embodied for cases of this sort. If the customer wishes to give an entertainment or to use an excess number of lights for some unusual occasion, he notifies the company to that effect, ten hours in advance, and if the necessary station capacity is available a man is sent to the house to disconnect the limiting device temporarily, so as to allow the use of as many lights as may be desired. No increase in the customer's fixed charge is made for this, but a charge of $1 is made for each time that the limiting device is disconnected and reconnected.

After the reading of Mr. Wallis' paper on Tuesday morning Mr. George E. Tripp, of Boston, chairman of the Committee on Uniform Accounting, presented the committee's report. In the discussion following the presentation of the report Mr. W. N. Anthony, of Chicago, pointed out that the question of uniform accounting was of vital importance. Of the forty-eight companies which the Chicago Edison Company acquired, he stated, there was not one that had a satisfactory system of accounting; half of them were pretty near the verge of bankruptcy, although they did not know it, and were paying dividends when they had no right to do so. [He did not explain the source of the money that was paid out for dividends.] Mr. Anthony suggested that it would help matters if central station managers would send their accountants and bookkeepers to some of the convention meetings, in order that they might broaden their views and not be so bigoted in their methods of accounting. Mr. C. F. Hewitt, of Elkhart, Ind., expressed the wish that there might be some means available whereby the association could obtain from every city operating its own electric light plant reliable data showing the actual cost of operation, and President Cahoon replied that this had been tried in vain.

Mr. Smith (Somerville, Mass.) expressed the opinion that the majority of central station managers do not know what it is costing per kilowatt-hour to produce current, and cited an instance in which the manager of a station not far from Boston had had a proposition submitted to him for supplying him with all the current he required at a certain price per kilowatt-hour and he did not know what to do about it because he did not know whether the cost at which he was producing current was as cheap as the offered price or not. Mr. Anthony expressed the opinion that a system of blanks and a method of accounting should be employed which would enable a station manager to ascertain the cost per month of producing current, the system being such as to enable one to find out within a few days after the close of any month what the cost for that month had been. Mr. Anthony also advocated the classification of taxes as an operating expense and not a fixed charge. After some further discussion of the committee's report it was adopted, and a vote of thanks was tendered to the committee for the excellent work done in the preparation of the report.

The Tuesday afternoon session was called to order at 2:45 o'clock, and immediately after the session opened Mr. Francis W. Willcox read a paper on

"The Practical Side of the Incandescent Lamp."

Mr. Willcox referred to the well-known fact that a high-efficiency lamp is preferable for central station service, for the obvious reason that its use secures a greater capacity of machinery and conductors, and a lower cost of light production. He then considered the actual relative value of the 3.1-watt and the 3.5-watt lamps, taking into consideration the disadvantages of the high-efficiency lamp as opposed to the advantages mentioned. The 3.5-watt lamp, he explained, has a useful life of about 800 hours, while the 3.1-watt lamp has a useful life of about 400 hours. It will, therefore, require two high-efficiency lamps to give the same useful lighting service that is rendered by one 3.5-watt lamp. The 3.1-watt lamp saves 6.4 watts in power consumption, so that for a period of 800 hours the total saving would be 5120 watt-hours as compared with a 3.5-watt lamp. This saving must be compared with the cost of an additional lamp. Figuring the price of the lamp at 18 cents, it is evident that the figure per kilowatt-hour at which the two lamps are equal in cost is found by dividing 18 cents by 5.12, which gives a cost of 3½ cents per kilowatt-hour. Below this figure the 3.5-watt lamp shows the lower cost, above it the 3.1-watt lamp is the cheaper. It must be noted, however, that these figures do not cover the value of the increased capacity in apparatus and lines resulting from the use of a higher efficiency lamp.

Besides the mere question of cost, the 3.1-watt lamp has the advantage of compelling timely renewals by burning out just beyond the end of the period of useful life. A large number of lamps tested by the Lamp Testing Bureau were allowed to burn until they broke instead of being taken down when the candle-power had diminshed to 80 per cent of the rated power. The tests showed that the majority of the breakages occurred in the vicinity of the 500 and 600-hour points. Another feature of advantage in high-efficiency lamps is the better quality of light, its greater brilliancy and whiteness, and consequently more attractive appearance. Candle-power, Mr. Willcox stated, does not completely express the value of an illuminant, as is well known. It affords a satisfactory measure of light for use in reading—in the illumination of black and white, but the power of the light to bring colors increases with the temperature of the filament out of all proportion to the candle-power. Therefore, the high-efficiency lamp has the advantage as an illuminant against a low-efficiency lamp in most branches of modern lighting service, such as the illumination of show windows, stores, picture galleries, etc. With reference to lamp voltages, Mr. Willcox advocated the avoidance of lamps of the so-called standard voltages of 100, 104, 110 and 115, for the reason that the demand for lamps of these voltages is many times the supply and the purchaser therefore serves his own interests best by adopting some uncommon voltage, such as 107, 108, 113, 117, 122, etc.

Referring to high-voltage lamps (of 200 to 250 volts), Mr. Willcox stated that there are over 500,000 of these lamps annually supplied to consumers in the United States, and that their use is being rapidly extended. Such lamps, however, until very recently have been limited to low efficiency, averaging four watts per candle. At this efficiency they give a useful life about 50 per cent better than the 100-volt 3.1-watt lamp. They require, however, about 20 per cent more power in station capacity for the same output in candle-power, and this has been a great drawback to their use. The superior distributing advantages of the 200-volt system and the resulting demand for these lamps have caused strong efforts to improve their efficiency, with the result that 250-volt lamps of an initial efficiency of 3.4 watts per candle for 16-c.p. and 20-c.p. lamps, and 3.1 watts per candle for higher candle-powers are now made to give an average useful life as good as the 100-volt 3.1-watt lamp, that is, about 450 hours.

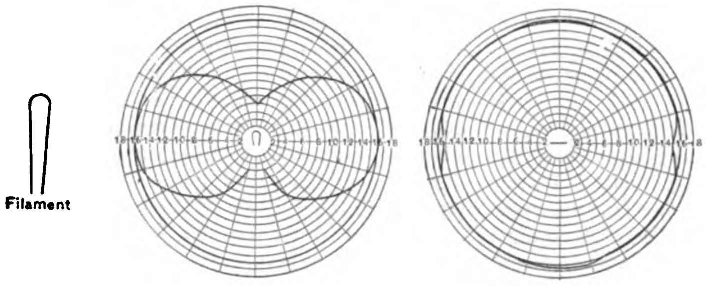


FIG. 1.—SINGLE LOOP FILAMENT.

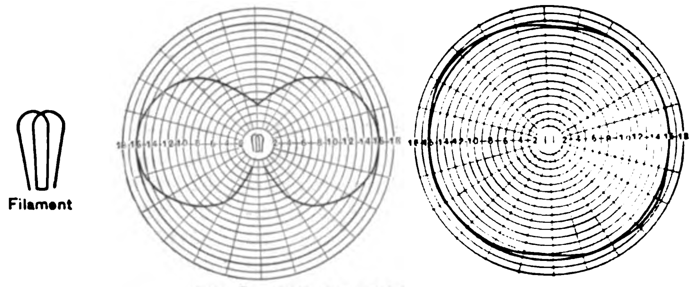


FIG. 2.—DOUBLE LOOP FILAMENT.

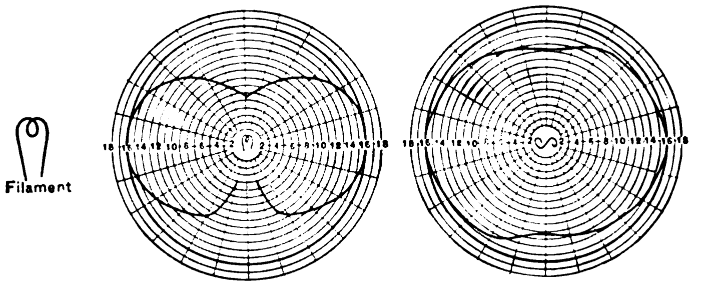


FIG. 3.—SINGLE COIL FILAMENT.

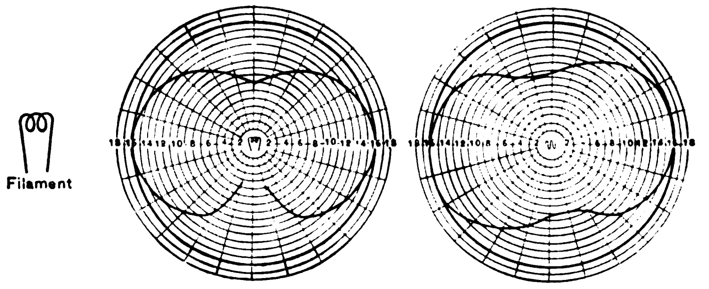


FIG. 4.—DOUBLE COIL FILAMENT.

With regard to candle-power, Mr. Willcox stated that while 16 candle-power still remains the standard of service in this country, there has been in the past few years a large and constantly increasing use of lamps of lower candle-powers, such as 10, 8, 6, 4, and 2. The lower the candle-power of the lamp, for a given efficiency, the more delicate becomes the filament, of course, and for equal results in life, therefore, lamps of low candle-power must necessarily have lower efficiencies than lamps of 16 candle-power. Table 1 herewith shows the average useful life of lamps of different candle-power at various efficiencies. The use of the lower candle-power lamps, Mr. Willcox stated, should be more general than it is, and they are to be recommended to all central station managers who desire to increase their business, especially among residences.

TABLE I.—SHOWING USEFUL LIFE OF INCANDESCENT LAMPS.

Watts per candle.	8-c.p.	10-c.p.	16-c.p.
3.1	...	335 hrs.	450 hrs.
3.5	610 hrs.	750 "	800 "
4.	1110 "	1650 "	1600 "

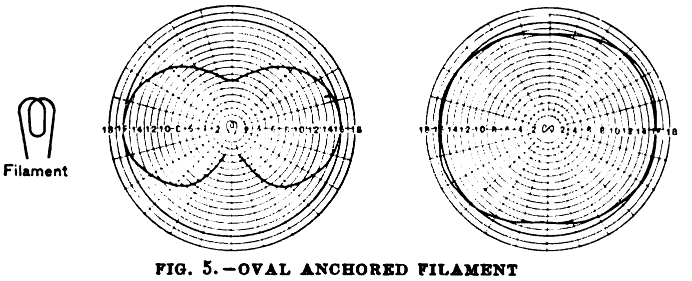


FIG. 5.—OVAL ANCHORED FILAMENT

Mr. Willcox did not advocate the use of lamps of higher candle-power than 32. With reference to types of filaments, he presented the curves shown in Figs. 1 to 5, which speak for themselves. In each illustration the shape of the filament is shown on the left, the distribution of light in a vertical plane is shown next, and at the right is shown the distribution of light in a horizontal plane, in other words, the distribution below the tip of a lamp hung vertically.

Referring to the candle-hour performance of incandescent lamps, Mr. Wilcox pointed out that tests for candle-hour curves are conclusive only when there are tested a sufficient quantity of lamps of one make to secure a fair average, when the methods of testing are correct, and finally when the duration of the test is sufficient to bring out the qualities of the lamp. One of the details of importance in making such tests is to have the initial efficiency of the lamp accurately determined, certainly within 1/10 watt per candle. Such a difference seems a small one, and it might be thought that it can be ignored, but it is sufficient to cause a difference of 100 hours in the performance of lamps of equal quality. The preferable efficiency at which to test lamps is 3.1 watts per candle, as lamps burned at this efficiency will give complete results in about one-half the length of time necessary for lamps burning 3.5 watts. If it is not possible to obtain lamps which correctly measure 3.1 watts per candle, the pressure can be raised at the socket so as to increase the candle-power up to the desired point, or the lamps can all be burned at a common voltage at various efficiencies and the results can afterward be corrected by the application of a correction factor taken from the chart shown by Fig. 6.

The curves in this chart give the changes of voltage, watts per candle and life corresponding to different candle-powers. These curves enable one to make the following comparisons: Given a certain candle-power and life, one can find the candle-power at another life, or the life at another candle-power; with a given candle-power and voltage one can find what the candle-power would be at another certain voltage, or what voltage would be required for another candle-power; given the candle-power and efficiency in watts per candle, one can find what the candle-power would be at another efficiency, or what the efficiency would be at another candle-power; given the voltage and life, one can find what voltage would be required to give some other life, and what life would result by using some other voltage; given the voltage and efficiency, one can find what voltage would be required to give any other definite efficiency, and what the efficiency would be at any other definite voltage; given the efficiency and life, one can find what the efficiency would be at another life, and what the life would be at any other given efficiency.

When the filaments differ in type, equal efficiency in watts per candle by horizontal candle-power measurements does not mean an equal strain on the filaments, nor form an exact basis of comparison. In such cases it is necessary to consider the total spherical candle-power, and one of two courses may be pursued, namely, (1) determine the watts per horizontal candle-power at which the different filaments in comparison with some standard will be on an equal basis of comparison, and set the different filaments up for candle-hour test at these respective efficiencies by horizontal candle-power measurement; (2) burn the lamps at an agreed initial efficiency, say 3.1 watts per horizontal candle-power, and then correct the results by the application of a correction factor determined for the different forms of filaments in terms of some standard filament. The accompanying table contains in one column the efficiencies as suggested by the first method, and in the other column the percentage ratios required for the use of the second method.

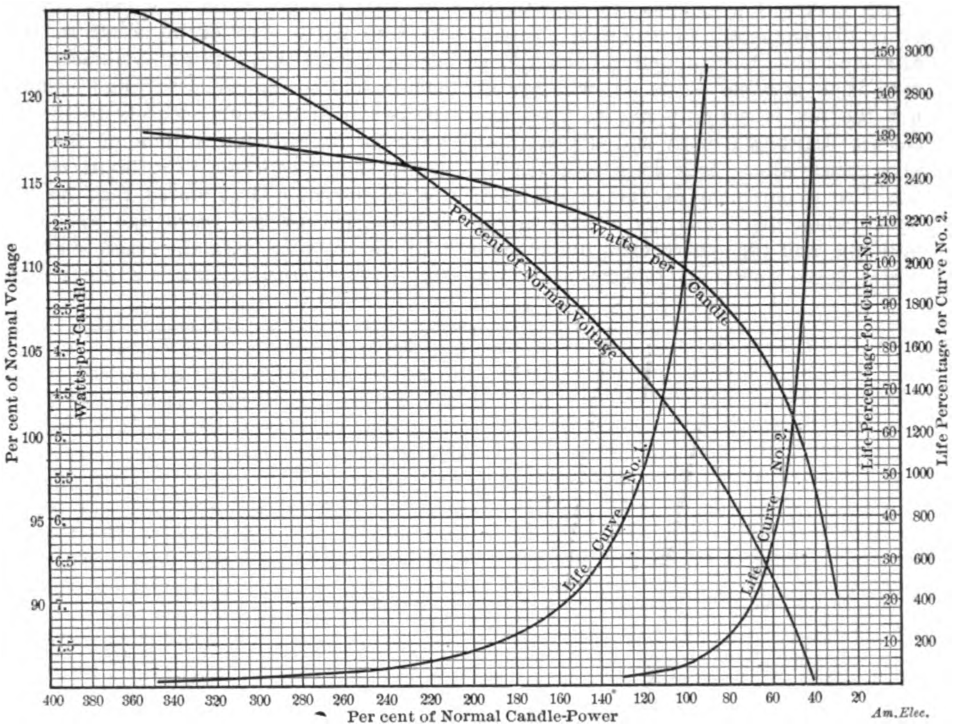


FIG. 6.—CHART SHOWING RELATION BETWEEN VOLTAGE, EFFICIENCY. CANDLE-POWER AND LIFE.

TABLE II.—TABLE FOR REDUCING RESULTS OBTAINED WITH DIFFERENT TYPES OF FILAMENTS, TO AN EQUAL COMPARATIVE BASIS, TAKING THE OVAL FILAMENT AS A STANDARD.

Type of filaments.	Hor. W. P. C. at which to test lamps of various type filaments in order to burn them at the same temperature as oval filaments at 3.1 Hor. W. P. C.	Factor by which to multiply effective life of various type filament lamps burned at 3.1 Hor. W. P. C. in order to equate them with oval filaments burned at 3.1 Hor. W. P. C.
Oval	3.10	1.00
Single spiral.....	3.10	1.00
Double spiral....	3.12	1.03
Single loop.......	3.02	.855
Double loop......	3.025	.865

Mr. Willcox closed his paper by urging the use of free lamp renewals on the part of central stations, and argued very forcibly against allowing consumers to buy their lamps where and how they pleased. He described the method in vogue at the New Haven (Conn.) central station where the lamps in the business section are taken off the circuits and replaced with fresh lamps four times a year. The lamps brought into the station are cleaned by means of a small buffing lathe and photometered, or rather passed through a photometer, in order to ascertain whether they are above or below the "smashing" point.

After a very short discussion of one or two points in Mr. Willcox's paper, and some announcements relating to entertainment features, the report of the Committee on the Standard Candle-Power of Incandescent Lamps was read by Mr. James I. Ayer in the absence of Dr. Louis Bell, chairman of the committee. The report stated that the committee had suspended action with regard to standard specifications for testing incandescent lamps, on account of developments in the shape of lamp filaments which seemed to render the conventional method of measurement (horizontal measurement with the lamp spinning) not universally applicable. The report stated, however, that the committee had effected an understanding with the officers of Columbia University, New York, whereby the University was prepared to undertake the preparation of standards and such testing as might be desired by the National Electric Light Association on condition that the association should bear the expense of adding a certain amount of special apparatus to the present University equipment for the work of standardization. About $1000 would be required to complete the equipment of the University laboratory, and the committee requested authority to carry out the plan outlined in the report. After reading the report Mr. Ayer explained that although the sum of $1000 would be required initially for standardizing apparatus, as explained, the officers of Columbia University proposed refunding the money to the association in yearly payments and taking over the title to the additional apparatus. After some discussion a motion by Mr. George F. Hubley, of Louisville, Ky., to refer the matter to the Executive Committee for further action and with power to act was carried.

The session adjourned at 4:30 o'clock and the delegates visited the power house of the Niagara Falls Power Company in response to an invitation from that company which had been previously tendered.

WEDNESDAY'S SESSIONS.

At the Wednesday morning session Mr. James I. Ayer, of the Committee on Amendments to Freight Classification of Electrical Apparatus, read the report of that committee. The report pointed out that numerous efforts to obtain satisfactory action from the Central Traffic Association with regard to readjusting the freight classification of electrical apparatus had resulted in nothing more than a series of stereotyped letters of a negative character, and Mr. Ayer, after reading the report, expressed the belief that nothing would ever be accomplished at the hands of the Central Traffic Association. He strongly recommended as a method of obtaining justice at the hands of the various railway companies that the matter be carried into court in a test case, the basis for which could be obtained by shipping two castings, one a dynamo casting and the other an engine casting, paying the freight across two States, in which case one casting would be classified as first-class and the other as fourth class, and then bringing suit to have the classification on electrical apparatus readjusted so that such apparatus would not be charged at higher rates than engines, lathes or other similar machinery. Mr. Ayer further expressed the opinion that the necessary money for such litigation could be easily obtained from interested shippers and manufacturers, and that it need not cost the association anything.

Mr. P. S. Tilden, of New York, said that his experience with railway classification committees had been exactly the same as that of Mr. Ayer, and suggested that the better way to obtain a just classification would be to bring suit to deprive railroads of their charters for discriminating against one line of goods. A motion of Mr. White and seconded by Mr. Slade, to the effect that the Freight Classification Committee be instructed to bring suits and take whatever steps might be necessary to bring about the desired classification was then put and carried.

An interesting paper on "Arc Lighting at the Beginning of the Twentieth Century," was next read by Mr. H. W. Hillman, of Schenectady. An abstract of the paper appears elsewhere in this issue.

After the discussion of Mr. Hillman's paper the meeting went into executive session, during which the officers for the ensuing year were elected. The newly elected officers are: Henry L. Doherty, of Denver, Colo., president; Louis A. Ferguson, of Chicago, first vice-president; Charles B. Hunt, of London, Ont., second vice-president. The members of the Executive Committee elected to serve during three conventions are Charles L. Edgar, of Boston; D. P. Robinson, of Seattle, Wash.; and C. C. Howell, of Knoxville, Tenn. The members elected to serve during two conventions are E. L. Bemis, of New Orleans, and Dudley Farrand, of Newark, N. J.

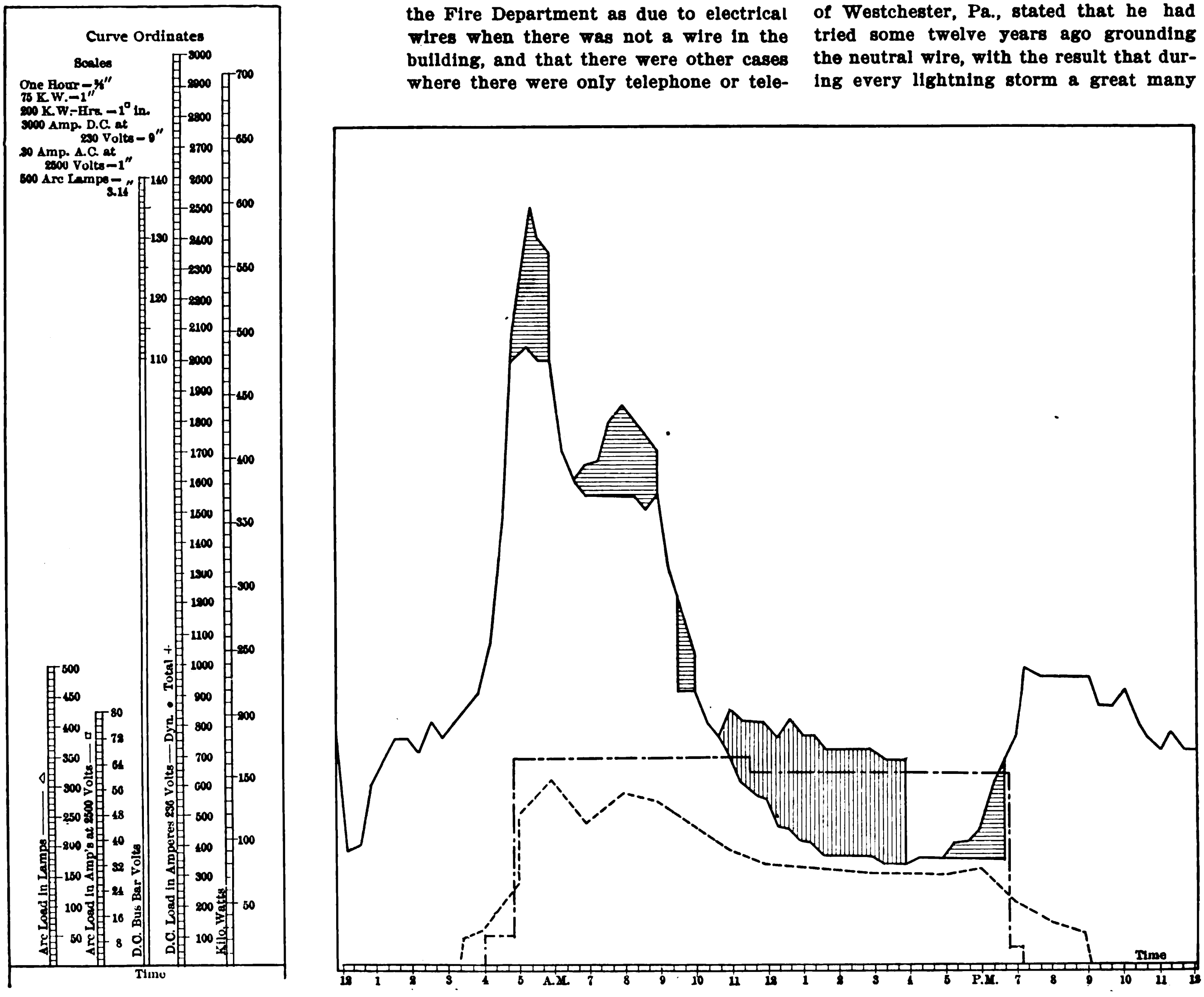


FIG 7.—A SPECIMEN DIAGRAM OF MIXED LOADS, WITH SCALES.

The Wednesday afternoon session opened with the discussion of Mr. Wallis' paper, which has already been given. At the close of this discussion the Committee for Investigating the Photometric Value of Arc Lamps presented its second progress report. The formal report of the committee was read by Prof. Goldsborough in the absence of Mr. Doherty, the chairman, and Prof. C. P. Matthews, who made the photometric investigations for the committee, read the remainder of the report, in which are described the methods and results of his tests. An abstract of this part of the report is published on another page.

Following the discussion of the report Capt. William Brophy, of Boston, chairman of the Committee on Rules for Electrical Construction and Operation, and the Committee on the Grounding of the Neutral Wire of Three-Wire Systems presented the reports of these committees. The first report stated that in the city of Boston during the past seven or eight years, notwithstanding the great increase of electric lighting, there has been a steady decrease in the number of fires attributable to electrical causes. One reason for this is that there is a bureau in Boston which makes it a business to investigate every fire supposed to originate electrically, and this bureau determines, whenever it is possible to do so, whether or not the fire is actually due to electrical causes. Captain Brophy stated that there were cases where fires were reported by the Fire Department as due to electrical wires when there was not a wire in the building, and that there were other cases where there were only telephone or telegraph wires in the building. He recommended that copies of the rules of the National Board of Fire Underwriters, which are practically identical with the rules originated by the Electric Light Association, be printed by the association and distributed broadcast, and that the association insist upon the observance of the standards established by this code of rules.

The report of the Committee on the Grounding of the Neutral Wire was practically a confirmation of its report made last year, and recommends unequivocally grounding the neutral wire of the three-wire system whether supplied from transformers or from direct-current generators and also recommends grounding two-wire secondary transformer circuits, preferably at the center of the secondary coil, but where this is not practicable the grounding of one of the secondary circuit wires is recommended. Captain Brophy pointed out that the provision of a mere connection to earth was of no avail in such cases, as the earth is an extremely poor conductor; the so-called "ground" connections should be made securely to the water-pipe or gas-pipe system of the city, preferably the former. Mr. James E. Pyle of Westchester, Pa., stated that he had tried some twelve years ago grounding the neutral wire, with the result that during every lightning storm a great many lamps were burned out, so that the grounding had to be discontinued. The two reports were adopted and the session then adjourned.

THURSDAY'S SESSION.

The Thursday morning session was called to order promptly, and the report of the secretary and treasurer of the association, showing a balance on hand January 1, 1901, of $6001.64, was presented and approved. Mr. McCabe, in the absence of the author, then read a paper by Mr. C. R. Van Trump, of Wilmington, Del., on

"A Station Load Diagram."

The common methods of recording the output of a plant are:

First—To put down the readings on the indicators by figures. These convey no idea of the character of the output without being again plotted into curves and integrated into the mean values, which requires an enormous amount of clerical labor, and for this reason many times they are not worked up. Again, they do not indicate immediately the character of the load chart, which is essential because the facts that are to be shown are just as important to the engineer operating at the time as to the manager of the plant.

Second—The cross-section load diagram plotted at the switchboard. This tells its story at once and the integrated values may be computed by means of planimeter. The disadvantages of such a chart are, the expense of the cross-section diagrams, that any changes in the character of the load require new diagrams, and the difficulty of arranging them with a common ordinate, because of the different loads to be plotted.

In the Wilmington station the switchboard data are divided into two classes: first, the load diagrams which show the output of the station, and second, the subdivisions of the diagrams or loads as between the different dynamos and circuit; that is, the distribution of the load within the station. The load diagrams are plotted as indicated by the part of a specimen sheet shown by Fig. 7. Numerical records of the loads on each machine are inscribed on the lower half of the sheet (not shown) at intervals of an hour, but the points of the curves are recorded every 20 minutes. The method of plotting these curves is a prominent feature of the system. The apparatus for this purpose consists of a board over the surface of which a horizontal ruler is arranged to slide vertically, the ends of the ruler being attached to pulleys which pass over cords at each edge of the board and keep it always parallel with the sheet. The edge of the ruler is graduated exactly like the scale shown at the bottom of the diagram in Fig. 7. On one side of the board are fastened five vertical scales, which are reproduced to the left of the diagram in Fig. 7. These are covered by a piece of transparent celluloid to avoid wear. The scales representing the various loads are laid out in proportion to the common ordinate of kilowatts at the lamps, which is shown in the extreme right-hand scale of the group. For example, the first scale on the left is figured at 470 watts for each arc lamp; next is the scale for the alternating-current load in amperes at 2500 volts; the middle scale is that of the direct-current bus-bar voltage; and the fourth scale is the scale of the direct-current output figured at 236 volts at the lamps.

In attaching the sheet to the board the attendant adjusts the sheet until the scale at the bottom of the diagram portion coincides exactly with the scale of the ruler, and then secures the sheet in this position with spring clamps. He reads the loads to be recorded every twenty minutes on the several systems; runs his ruler to the point indicated for the load, on the proper index at the left, makes a point and circumscribes it with the character representing that load—a circle for the total incandescent load, a cross for the total direct-current dynamo loads, a square for the alternating-current load, and a triangle for the arc lighting load. As these points are recorded he connects them with a light line, and cross-sections the output from the storage battery horizontally and the intake vertically.

At the end of the twenty-four hours the load sheet is duly signed and sent into the office; the mean loads are calculated by means of a planimeter and duplicate board. To make all the calculations on any one of the sheets, including meter records on a number of wattmeters, the intake of rotary transformers and the receiving boards from a water-power transmission plant, requires considerably less than one-half hour of the time of one of the clerks in the office.

There being no discussion of Mr. Van Trump's paper, Mr. Ayer presented a report on the street lighting of a dozen representative cities which had been made by a committee of the City Council of Cincinnati, and suggested that the report be recorded in the proceedings of the association, as it contained some very valuable central station data; this was accordingly done. Mr. Chas. R. Maunsell, of Topeka, Kan., then opened a topical discussion on

"Steam Heating from Central Stations."

Mr. Maunsell described his company's plant, which is operated in conjunction with a central station. The steam-heating plant includes 52,257 sq. ft. of radiating surface, and 8500 sq. ft. of covered pipe surface. During very light loads the steam-heating system has to be supplemented with live steam through a reducing valve. The consumer pays for all of the apparatus in the building except the meter, and maintains it in proper condition subject to the company's inspection. During the first year of operation the revenue received from the heating service paid 55 per cent of the cost of coal during the heating season; during the second year the heating service revenue paid for 60 per cent of the coal; during the third year it paid for 72 per cent of the coal; and during the year which is now closing (the plant has been in operation about four years) the income from the heating service paid 90 per cent of the total coal bill. With a total gross revenue of $11,000 the total expense on account of the heating system, excepting the coal, was $280. The company has found that flat rates for small consumers and meters for large ones is the most satisfactory system. Five per cent per annum is put aside to cover depreciation, although during the four years of operation the company has not had to open any of the streets to inspect or repair the mains. In several cases power and lighting contracts have been obtained from large consumers who, if they had not been supplied with heat, would have put in isolated power and lighting plants of their own.

Mr. Chas. P. Welles, of Towanda, Pa., was the second speaker on the subject. Mr. Welles related the experience of his company from the installation of the plant five years ago up to the present time. Although the electric light plant has no day load and is a rather small central station, the gross lighting receipts being $7,500 a year, the operation of the heating system has enabled the company to pay off a floating debt of $2,500 which had been incurred previous to the installation of the heating system, and a debt of $4,000 incurred by the installation of that system. For the last three seasons the receipts from the heating service have paid the entire coal bill, the expenses of all extra labor required, and 6 per cent on the investment. Nothing was charged off for depreciation of the heating system for the reason that whenever the company has had occasion to tap a pipe or inspect a main there have not been any evidences of depreciation. The method of charging observed by Mr. Welles' company is based on the cubic feet of space heated. During the day, when there is no load for the electric light plant, live steam is used exclusively for all heating; and during the night a good deal of live steam is used to supplement the exhaust steam. The condensation from radiators is passed through cooling coils, or indirect radiating devices before being delivered to the sewer.

Mr. McCabe, of Newcastle, Pa., stated that steam heating had been tried in his town and was not a success. Further discussion brought out the fact, however, that the plant at Newcastle is solely a steam heating plant, operated at high pressure and not in connection with an electric lighting plant.

Mr. F. N. Jewett, of Chicago, called attention to a hot-water system of heating in use by the Albert Lea Electric Company, of Albert Lea, Minn. The company operates compound Corliss engines, so that it was not practicable to put in a steam-heating plant; a hot-water plant was therefore installed. The water is heated in a surface condenser and circulated throughout the town at a temperature to suit the weather conditions. This means that in mild weather, when the water can be circulated at 135 to 140 degrees temperature, the plant maintains a vacuum of 20 to 23 ins. on the engines and still gets latent heat in the steam for heating. In extreme weather that vacuum may be decreased to about 10 ins. and the water circulated at 175 or 180 degrees. The business section of the town is heated from the electric light plant with water circulated at 175 degrees, which in zero weather maintain 10 ins. vacuum on the engines.

The particular advantage of a hot-water heating system over one employing steam is that the heating can be varied to suit the weather conditions, whereas steam must be at the boiling point, at least 212 degrees, and the temperature cannot be varied to suit the weather conditions. Another difference is that with the hot water system no condensation is lost; all of it is returned to the boilers. Another point is that the mains required in the hot-water system will carry a given amount of business with pipes one-half the size of those required in the steam system. A 6-inch pipe in a hot-water plant will supply as much service as a 10-inch pipe in a steam heating plant, provided the pressure in the steam heating plant is kept down to a moderate limit. In a non-condensing plant steam is taken from a closed feeder, the surface condenser, and the exhaust pipe is carried out into the open where no back pressure is exerted.

This item of engine back pressure has a good many sides to it. If one can get additional power out of the engine by decreasing the back pressure—that is, the atmospheric pressure and expanding steam down to 26 ins. of vacuum—it is conversely true that by adding to the back pressure against the engine a certain amount of power is lost. The argument that this is overcome by raising the boiler pressure to a corresponding amount, is "chasing the devil around the stump," because if you raise the boiler pressure enough to overcome the back pressure, and do not have the back pressure, you will also increase the output of the engine.

Mr. Ernest Woodruff, of Atlanta, Ga., said that his company had installed a steam heating plant in Atlanta which was put in operation the first of last November, and that the experience during the one season has been very satisfactory so far. The receipts were about $10,000 and the company has signed contracts for $6-000 or $8000 of new business for next season. During the first three or four weeks there were one or two leaks in the mains, but they did not cause much trouble and steam was on the mains continuously. The company heats a twelve-story building and sells the heat on the meter basis, on the flat rate basis and on a graduated service basis. The plant is designed particularly with a view to utilizing exhaust steam, half of the engines in the station being high pressure non-condensing. These engines will be operated during the cold weather and compound condensing engines during the summer. The charge for heat on a flat-rate basis is from 25 to 50 cents, depending on the amount of radiation; on the meter basis the charge is 20 cents per 100 gallons of water.

Mr. Jewett then gave some additional information relating to a hot-water heating system in operation at Red Oak, Iowa, and Mr. J. F. Dusman referred briefly to the work done at York, Pa., in the way of operating a steam-heating system in connection with a central station.

At the close of this discussion, Mr. T. C. Martin, in the absence of the author, read a paper by Mr. Augustus Treadwell on "Storage Batteries in Central Station Work."

Mr. Treadwell pointed out the advantages obtainable by the use of storage batteries (1) to carry the peak of a load, (2) to carry the entire load during minimum service hours, (3) to act as a voltage equalizer or reservoir, and (4) for the equipment of sub-stations. He advocated the establishment of storage battery plants in large buildings in the place of the ordinary form of isolated plant, the batteries to be charged from the central station during the light-load period. He further cited several examples of storage battery operation in central stations. While it is difficult to lay down hard-and-fast rules concerning the proper capacity of a battery as compared with the capacity of the generating equipment, the author recommended as perhaps the best rule to follow that given in the London "Electrical Review" of December 8, 1899. This rule makes the capacity of the first battery 2½ ampere-hours per kilowatt capacity of generating plant, based on an 8-hour discharge rate for the battery. Should any other discharge rate be required the capacity of the battery should, of course, be changed correspondingly. The capacity at a 5-hour rate is 90 per cent of that at the 8-hour rate, while the capacity at the 2½-hour-rate is 72 per cent, and that at the one-hour rate is 52¼ per cent of the 8-hour-rate.

In the discussion which followed the reading of the paper, Mr. Chas. Blizard, of Philadelphia, pointed out that the almost universal practice nowadays is to install tanks and cells of about double the size that is actually necessary for the number of plates at first installed, in order that the capacity of the battery may be increased as the load on the station increases without having to change the tanks or jars. Mr. W. W. Donaldson, of New York, said that experiments which he had made lately showed that increasing the contact surface between the active material and its support not only increased the discharge capacity of the battery, but straightened out the e.m.f. curve so that instead of giving a curve which droops gradually from the start, the increased surface gave an almost straight line for the same period of discharge.

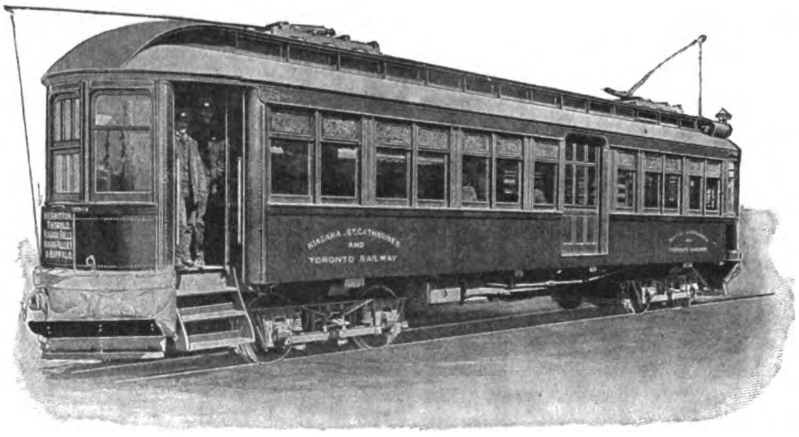
Mr. Elmer E. Sperry stated that the popular notion to the effect that compressed-air storage required less weight of apparatus for a given capacity than electrical storage was entirely erroneous. Some experiments which he had made sometime ago showed that a set of Manson tubes, holding compressed air at 2700 lbs. pressure, stored only 27 per cent of the energy that could be stored in a battery of accumulators of the same weight as the tubes and the contained air, and this percentage was only obtainable when the air was reheated and expanded through two series of cylinders at considerable cost. Mr. Sperry further pointed out that the stored energy in a battery can be delivered with a very slight fall in pressure; whereas in all other forms of power storage, such as heat, compressed air, etc., the pressure constantly drops from the beginning to the end of the delivery.

President Cahoon closed the convention with a short speech, which contained probably more sound advice and common sense than almost any other utterance of similar length during the entire convention. He pointed out forcibly and logically the advantages that must accrue to central station managers from attending and taking active part in the meetings of the association and investigating the performance of other plants as contrasted with remaining at home and failing to keep abreast of the progress outside their own plants. At the close of his remarks the convention adjourned *sine die*.

SOME UNOFFICIAL FEATURES.

The convention was graced by an unusual number of ladies, for whose benefit several enjoyable diversions were arranged. On Tuesday evening a merry party, comprising most of the delegates and ladies present, took a ride down the gorge trolley road by invitation of Manager Morgan. The turbulent rapids were illuminated by means of searchlights, producing a magnificent spectacle. Mr. Converse D. Marsh said it was a "gorgeous" sight, but in deference to the ladies he was suffered to go unmolested. On Wednesday evening a hop was given to the ladies of the convention.

On Thursday morning Mr. E. F. Seixas, general manager of the Niagara, St. Ca-



ONE OF THE CLOSED CARS OF THE N., ST. C. & T. R. R.

tharines & Toronto Railroad, placed a special car at the disposal of a party comprising Mr. and Mrs. W. K. Beard, of Philadelphia; Mr. and Mrs. Arthur E. Clifford, New York; Mr. and Mrs. Richard Fleming, Swampscott, Mass.; Mr. and Mrs. John D. Meister, New York; Mr. and Mrs. E. F. Phillips, Detroit, Mich.; Mr. and Mrs. Cecil P. Poole, New York; Mr. and Mrs. E. F. Seixas, St. Catharines, Ont.; Mr. and Mrs. Philip S. Tilden, Summit, N. J., and Mr. and Mrs. Elmer E. Wood, New York. The party was taken to St. Catharines and thence to Port Dalhousie, where the Lake Ontario end of the Welland Canal is located. Thence they returned to St. Catharines where Mr. Seixas had had a palatable luncheon prepared, to which everyone did full justice. After lunching, the ladies were presented with handsome souvenir pins and the party returned to Niagara Falls.

The road passes through one of the most beautiful sections of Canada and affords landscape and water views that are fascinating in the extreme. The cars are of unusual size, equipped with two 50-h.p. motors, and run at 30 and 40 miles an hour over some stretches of the road. Each of the closed cars is divided into three compartments: one for passengers, in which smoking is not allowed; one for smokers, and a third for baggage and express parcels. The company also operates freight trains, which are at present drawn by steam locomotives, but electric locomotives are being built to supplant these. One of the combined passenger and baggage cars is shown by the half-tone engraving on page 336.

The track is single, with turnouts of course, and a notable feature, which speaks volumes for the management, is that one car never has to wait for another at a turnout, unless there should be an actual breakdown. There are two trolley wires hung 12 ins. apart; the cars going one way use one wire and those going in the opposite direction use the other wire. With this arrangement no trolley feed wires are needed and no overhead switches are required at turnouts; each wire simply follows the right-hand track of the turnout. The line is supplied with current from two rotary converter substations which receive high-tension current from the big Niagara Falls power house and are located at suitable distances apart along the route.

CONSTRUCTION, CALIBRATION AND CARE OF STEAM GAUGES.

BY C. W. OBERT.

The first and simplest form of steam gauge was the U tube, or manometer. It consisted of a U-shaped glass tube partly filled with mercury, with pressure from the boiler admitted to one leg, thus lowering the level in that leg and raising it in the other. Measurements made between the two levels determined the pressure. This was a very crude gauge, but it was much used in the early days of steam engineering, being actually required by the French Government in 1840 on the low-pressure boilers of that time. As higher pressures began to be used the manometer gave way on account of the great height of mercury column rendered necessary, and its consequent unwieldiness, to mechanical devices for pressure measurement. The first mechanical pressure gauge was constructed so as to indicate the deflection of a thin flat metal disc exposed to the pressure on one side and to the atmosphere on the other, each increment of deflection corresponding to a certain definite pressure. This is known as the "diaphragm" gauge, and was invented in 1849.

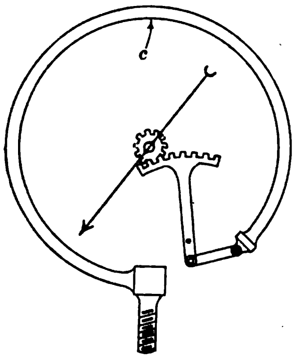


FIG. 1.—SINGLE BOURDON GAUGE.

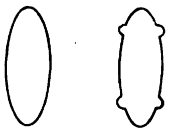


FIG. 2.

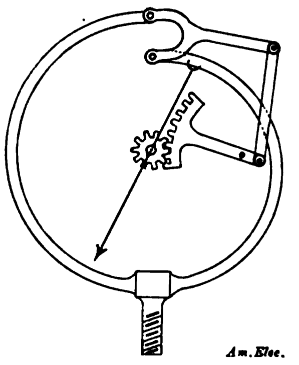


FIG. 3.—DOUBLE BOURDON GAUGE.

There are now two principal types of mechanical pressure gauge; the "bourdon tube" and the "diaphragm;" practically all the gauges in use at present being adaptations or modifications of one or the other of these two types. In all gauges the pressure indication is dependent on a spring which is designed to undergo a known degree of deformation for each unit of pressure acting upon it, the deformation being magnified and rendered visible by the movement of a needle over a dial.

The bourdon tube gauge has for its controlling spring a peculiarly-shaped compound spring consisting of a hollow brass or steel tube bent into an arc of a circle; the sides are permitted to come together by such bending, so that the cross-section of the tube is that of a very much flattened oval. When pressure is admitted on the inside of this tube the parallel sides tend to separate, and in separating they tend to bring the tube into a straight line. This effort to straighten out is the deformation previously referred to, and is indicated by a needle actuated through a multiplying gearing connected to the tube. Fig. 1 shows the simplest form of bourdon gauge spring, and two typical cross-sections are shown in Fig. 2. The corrugated form shown at the right of Fig. 2 is sometimes employed in order to give the tube greater rigidity.

The single-spring type of bourdon gauge shown in Fig. 1 is open to two very obvious objections. The closed end of the spring tube beyond the point *c* is an unavoidable pocket in which water may accumulate from the condensation of steam, and, since once in there it cannot drain out, it remains, ready to freeze in cold weather and ruin the spring. The second objection is that the great length of the single spring renders it sensitive to the least vibration, making the indications of the needle disagreeable and sometimes difficult to read under portable-engine and locomotive conditions. These objections led to the production of the double-spring bourdon gauge, the mechanism of which is shown in Fig. 3. In this form of spring the "pocket" difficulty is entirely removed, as the condensation readily drains out, and the shorter length of the springs tends to greater stability, and steadiness, although at a loss of sensitiveness. The multiplying gearing is connected to both springs differentially so as to add up and magnify the combined deformations of the two springs and thus give the pointer a sufficient scale movement. In both forms the bourdon spring is rigidly supported at the point where the fluid under pressure enters, so that the closed end is subjected to the entire movement of deformation, thus giving the greatest possible range to the indicating gear.

The diaphragm type of gauge is, as stated before, dependent for its action upon deformations of a thin disc of spring metal caused by pressure acting on one side. The flat disc, however, soon gave way to the corrugated disc owing to the impossibility of a flat disc, rigidly fastened at its circumference, yielding to deformation from pressure without eventually either cracking or becoming permanently "set." Fig. 4 shows a diaphragm gauge in which is used the corrugated diaphragm; the pressure below the diaphragm dishes the disc upwardly, thus raising a rod and actuating the indicating mechanism. This gauge gives a very steady indication at the pointer and is always drained of con-

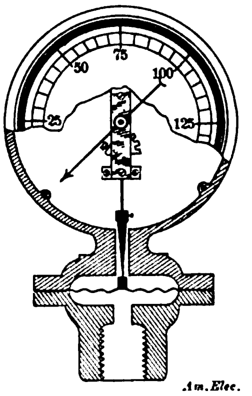


FIG. 4.—CORRUGATED DIAPHRAGM GAUGE.

densation; but unless the diaphragm is of the best material and the utmost care is used in the process of corrugating, it is liable to crack after a considerable period of use.

A form of corrugated spring diaphragm has been devised which is not fastened rigidly at its circumference. It consists of two corrugated spring-metal discs with their circumferences flanged and locked into an elastic band, as shown in Fig. 5. Pressure is admitted through the lower disc to the interior of this spring box and the resultant longitudinal expansion is the deformation that is measured by a pointer gearing to indicate the pressure. In a gauge embodying this spring box a given movement of the pointer requires only one-half as much deflection in each of the diaphragms as would be required for the same pointer movement and gear ratio in a single-diaphragm gauge, and therefore the two diaphragms may be made heavier and more durable.

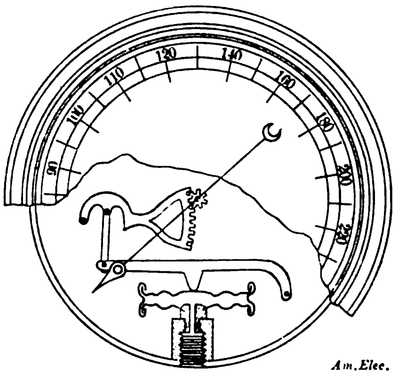


FIG. 5.—DOUBLE DIAPHRAGM GAUGE.

It is interesting to note that the mercury gauge, or manometer, which was long ago discarded from practical use, is to-day the fundamental standard in calibrating new gauges or correcting old ones. The calibration of a pressure gauge is effected by subjecting the gauge to definite known pressures and marking on the dial the position taken by the pointer for each definite pressure. There are two methods of determinig tne known pressure used in calibrating. One is to connect the gauge which is to be tested to a source of hydraulic pressure, which pressure is also applied to a valve closing an opening exactly one square inch in area. By loading this valve with a series of known weights and observing and marking the positions of the pointer when the liquid pressure lifts the valve with each load, the gauge is calibrated. The correctness of this method depends upon the accuracy with which the square-inch valve is made as well as the accuracy with which the precise values of the calibrating weights are determined.

The ultimate standard for accuracy is, however, the mercury column, and is the method usually used for calibration. The gauge to be calibrated is connected on the same pipe which opens from the pump into the short leg of the mercury column, and the positions of the pointer are observed and marked on the dial when the mercury stands at heights corresponding to certain definite pressures. The heights to which the mercury is raised for each definite pressure are based on the fact that 2.038 ins. of pure mercury at 60 degs. Fahr. in the column corresponds to 1 lb. per square inch.

Pressure gauges working on the principles described can have no pretensions to scientific accuracy, as changes of temperature affect the elasticity of the tubular springs and spring discs to degrees difficult to discover and allow for. They are, however, accurate enough for practical purposes, and will remain so if not subjected to undue heating. The spring tubes or discs will change in shape so as to assume a permanent "set" if hot steam comes in contact with them, and for that reason hot steam must not be allowed to enter a steam gauge. An inverted siphon, or U-shaped tube, filled with water, should be inserted between the gauge and the boiler, so that the pressure may force the water up and hold it in and against the spring tube or disc. The water will transmit the pressure perfectly, but will not transmit sufficient heat from the steam to be detrimental. The form of siphon generally used is made of a piece of pipe bent into a complete circle 3 or 4 ins. in diameter so as to trap the water in its lower half, although such a form is not essential. Any form of siphon that will allow nothing but water to enter the gauge may be used.

Many steam gauges are injured by being placed too near to the boilers, and thus being subjected to too high a temperature, causing the oil in the bearings of the movement to become gummed and to retard the free movement of the pointers. Instances have been known of gauges becoming so badly gummed as to cause the mechanism to stick so that the backlash hair spring could not return the pointer to zero. It is advisable where possible to place the gauge on a nearby wall at a suitable distance from the boiler, and where a connecting pipe can be run. The piping to the gauge should always be solid and tight, so that no steam may escape and strike against the gauge or work its way to the interior; the latter occurrence would probably corrode the movement, although the parts should preferably be of a metal not easily corroded in the event of accidental entrance of escaping steam or by the usual dampness of the average boiler room.

If a steam gauge becomes incorrect it is well to bear in mind before starting to repair it that it is impossible for anyone to adjust a gauge without the aid of a standard test gauge, or test apparatus of some kind to test the pointer by. Merely putting the gauge pointer back to zero will not make a gauge correct. When a gauge is suspected or known to be incorrect it should be sent at once to the maker or to some responsible firm having suitable facilities for repairing, testing and calibrating.

THE SELECTION OF A STEAM ENGINE

BY WILLIAM D. ENNIS, M. E.

In purchasing a steam engine for a certain specified purpose, a clear statement and understanding of all the conditions conduces toward a low contract price and satisfactory performance. The first consideration is the size. This depends upon the average load, the maximum load, the steam pressure, back pressure, number of revolutions and point of cut-off.

The most economical point of cut-off is, for simple engines, usually considered to be at from 1/5 to ¼ full stroke. It is usually good practice to buy an engine of suitable size to develop the average amount of power required at 1/5 cut-off; but if the load is highly variable, it may be necessary to make the engine larger than the rule would require in order that it may handle its maximum load. If the engine drives an electric generator, it should be capable of furnishing the amount of power that the generator will require when carrying its maximum momentary load.

The capacity of the engine depends upon the steam pressure, back pressure, cylinder dimensions and speed. The horse-power that will be developed in the cylinder is equal to $\frac{PLAN}{33,000}$ in which *P* is the mean effective steam pressure, *L* the length of stroke in feet, *A* the net area of the piston in square inches, and *N* the number of single strokes per minute. The value of *P* for engines actually in sevice is, of course, determined by means of an indicator. For a proposed engine it may be computed from the portions of an ideal indicator card, by the familiar formula:

$$P = \frac{P_1\,(1 + \text{hyp. log. Exp.})}{\text{Exp.}} - p,$$

in which *Exp.* represents the number of expansions; P_1 the initial pressure, absolute, and p the back pressure, absolute. For 1/5 cut-off, the formula becomes

$$P = 0.5219\ P_1 - p.$$

Allowing 20 per cent for the difference between the mean effective pressure thus calculated and that obtained in actual practice, the horse-power of a proposed simple engine is equal to

$$\frac{0.8\ (0.5219\ P_1 - p)LAN}{33,000},$$

or

$$\frac{(0.4175\ P_1 - 0.8\ p)LAN}{33,000}.$$

In practice a common piston speed is 600 ft. per minute. To compare a number of proposed engines on this basis the horse-power may be calculated by means of the reduced formula

$$\frac{(0.5219\ P_1 - p) \times (A - 0.5\ a)}{688}$$

in which *A* is the area of the piston, as before, and *a* is the cross-sectional area of the piston rod in square inches.

Having determined the size of engine required, from the foregoing and other considerations, there are still many points to be settled. Shall the engine be simple, compound or triple expansion? Shall it run condensing or non-condensing? Shall it have a standard girder frame, or a self-contained base, or must it be designed on heavy duty lines? Shall it be slow, medium or high speed? Shall it be governed by throttling or by varying the cut-off? Shall the valve gear be plain sliding, Corliss or gridiron?

For a multiple-expansion engine to be highly economical as compared with a simple engine of the same capacity the load must be constant within reasonable limits; the units must be large; the initial steam pressure must not be less than 125 lbs.; and the engine must be run condensing. The multiple-expansion engine costs more per horse-power of capacity than a simple engine; piping for pressures upward of 125 lbs. is expensive; but the condenser produces practically no additional cost, as it will be paid for by the increased capacity of the engine when running condensing.

A good condenser with an ample supply of cold water should maintain a vacuum of not less than 24 ins. on the engine for which it is designed. This is equivalent to 12 lbs. pressure, and acts for nearly the entire length of the stroke. If from the gain thus obtained we deduct 25 per cent to cover the cost of power to operate the condenser, and the slightly decreased vacuum at beginning and end of stroke, the saving due to the condenser is

$$\frac{9\ \text{LAN}}{33{,}000},$$

or the engine will use

$$\frac{900}{.41752\ P_1 - .8\ p}$$

per cent less steam than before.

If exhaust steam can be used for heating buildings or for warming water, it may be more economical to run the engine non-condensing. Let $q =$ the pounds of steam used by the engine per indicated horse-power per hour. The total amount of steam used per hour is then

$$\frac{(0.4175\ P_1 - 0.8\ p)\ \text{LAN}\ q}{33{,}000}.$$

Let $r =$ the percentage of this steam that can be utilized to heat buildings, feed-water, etc. The amount of steam that can be utilized after passing through the engine is then

$$\frac{(0.4175\ P_1 - 0.8\ p)\ \text{LAN}\ q\ r}{100 \times 33{,}000}.$$

If this exhaust steam can be circulated through coils or mingled with feed-water at two-thirds the effectiveness, pound for pound, of live steam, the amount of live steam saved by its use is

$$\frac{\frac{2}{3}\ (0.4175\ P_1 - 0.8\ p)\ \text{LAN}\ q\ r}{100 \times 33{,}000}.$$

This is to be compared with the amount that might be saved by the use of a condenser, which is $\frac{9\ \text{LAN}}{33{,}000}$. For the operation of a condenser to be economical, therefore, r must have a value less than $\frac{1350}{0.4175\ P_1 - 0.8\ p}$. Otherwise it will be cheaper to run on back pressure, venting surplus steam to the atmosphere.

The form of frame to be adopted for an engine depends upon the duty and also upon the condition of the sub-foundations. For loads liable to sudden variations, or where there is a liability to overload of considerable duration, or on soil of such a nature that good foundations are impossible, the frame must be extra heavy. Small engines may be self-contained; that is, having a continuous base under cylinder, guides and bearings. Larger engines subjected to heavy service as above described should have a single body from the cylinder, under the guides, to and including the main pillow block.

The question of speed is important. Generally, high-speed engines, with a comparatively short stroke, are more economical, because of the decreased time and surface for cylinder condensation. They require more attention and a greater expenditure for repairs than slow-speed engines. For direct connection to electric generators, especially in the smaller sizes, high-speed engines are essential. For other purposes they are not in so much favor. The first cost is low, as the frequency of the strokes allows the cylinder dimensions to be made small. The gain in economy due to decreased cylinder condensation is in many cases more than counterbalanced by the defects of the valve gear.

The only economical method of governing an engine is by varying the point of cut-off. This requires a special valve controlled separately from the main gear. The control should be positive, if possible, for the entire stroke, so that the governor will not lose control on light or heavy loads. The governor itself must be sensitive to the slightest variation in speed, and prompt and powerful in its action. These requirements are considered by most builders to be more satisfactorily met by a governor of the "fly-wheel" or "shaft" type than by the older fly-ball governor.

The type of valve gear is usually selected with regard to individual preference. Corliss valves for moderate speeds have shown some advantages over slide and piston valves. In the large units installed in central stations of the present time, the gridiron type of valve, with each port separately and positively controlled, appears to be most in favor.

Other minor points which should receive careful consideration before purchasing a steam engine are the following: Bearings; size and proportions, oiling connections and disposition of waste oil. Crosshead; how adjusted, if at all; method of connecting to the piston rod; the connecting-rod connection to the wrist pin; the cylinder drips; cylinder lagging or jacket; eccentric straps and rods; piston construction; throttle valve, and belt-wheel or fly-wheel.

SIMPLE METHOD OF OBTAINING TWO THREE-PHASE SECONDARY VOLTAGES.

Fig. 1 herewith represents diagrammatically a method of obtaining both 1000 and 2000 volts from a bank of three-phase transformers, which was employed by Mr. R. F. Hayward, consulting engineer for the Utah Light & Power Company, at the time several different plants were consolidated at Salt Lake City. It was necessary to supply both 1000-volt and 2000-volt alternating-current mains from a bank of transformers which stepped down from 10,000 to 2000 volts. In order to do this, a tap was led out from the middle of each transformer secondary and the 1000-volt circuit wires were connected to the three taps, as shown in the diagram. Fig. 2 is an elementary diagram illustrating the principle, and will help to make clear what is necessarily somewhat obscured by the wiring circuits in Fig. 1.

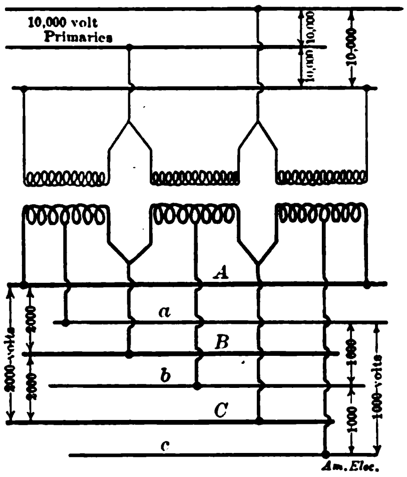


FIG. 1.—DIAGRAM OF CONNECTIONS.

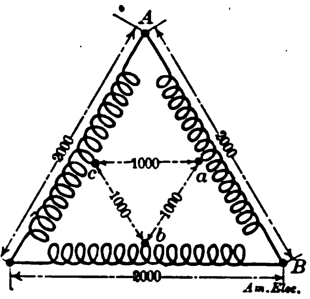
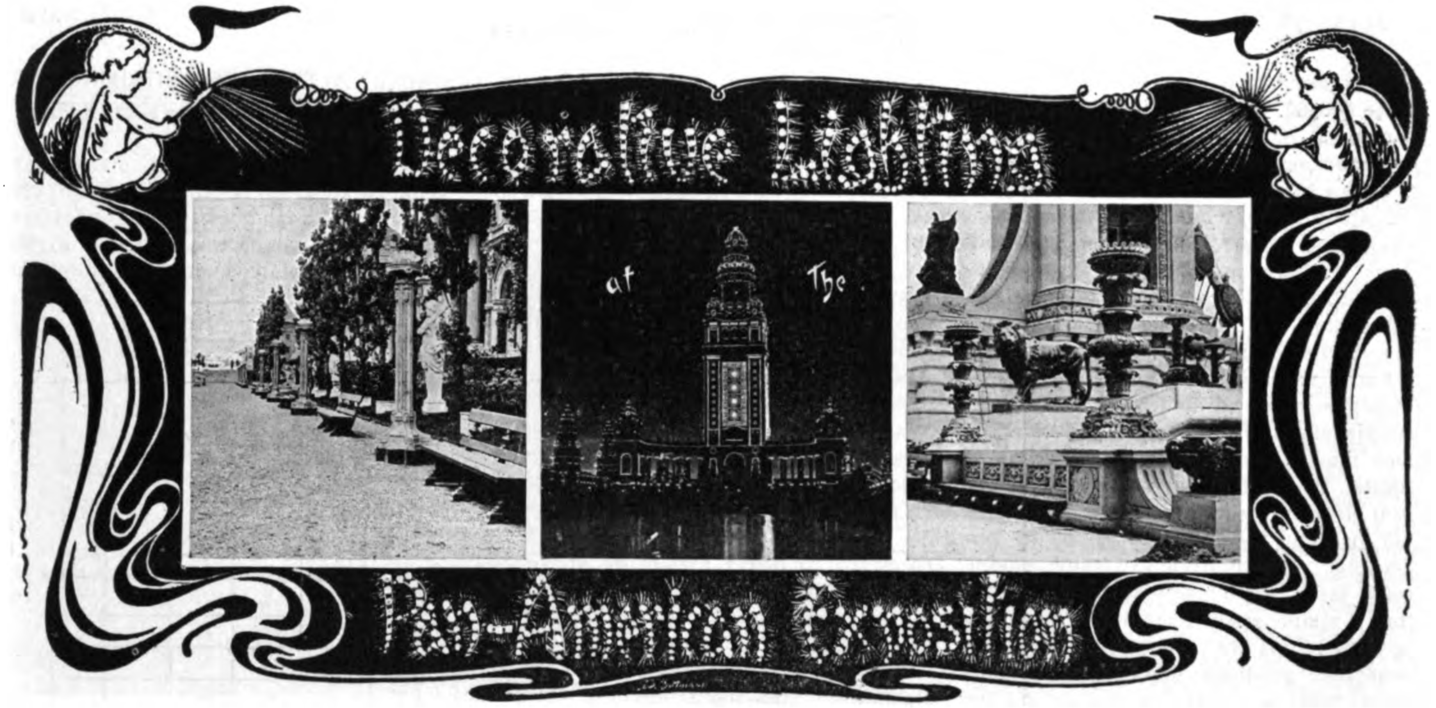


FIG. 2—ELEMENTARY DIAGRAM.

* * *

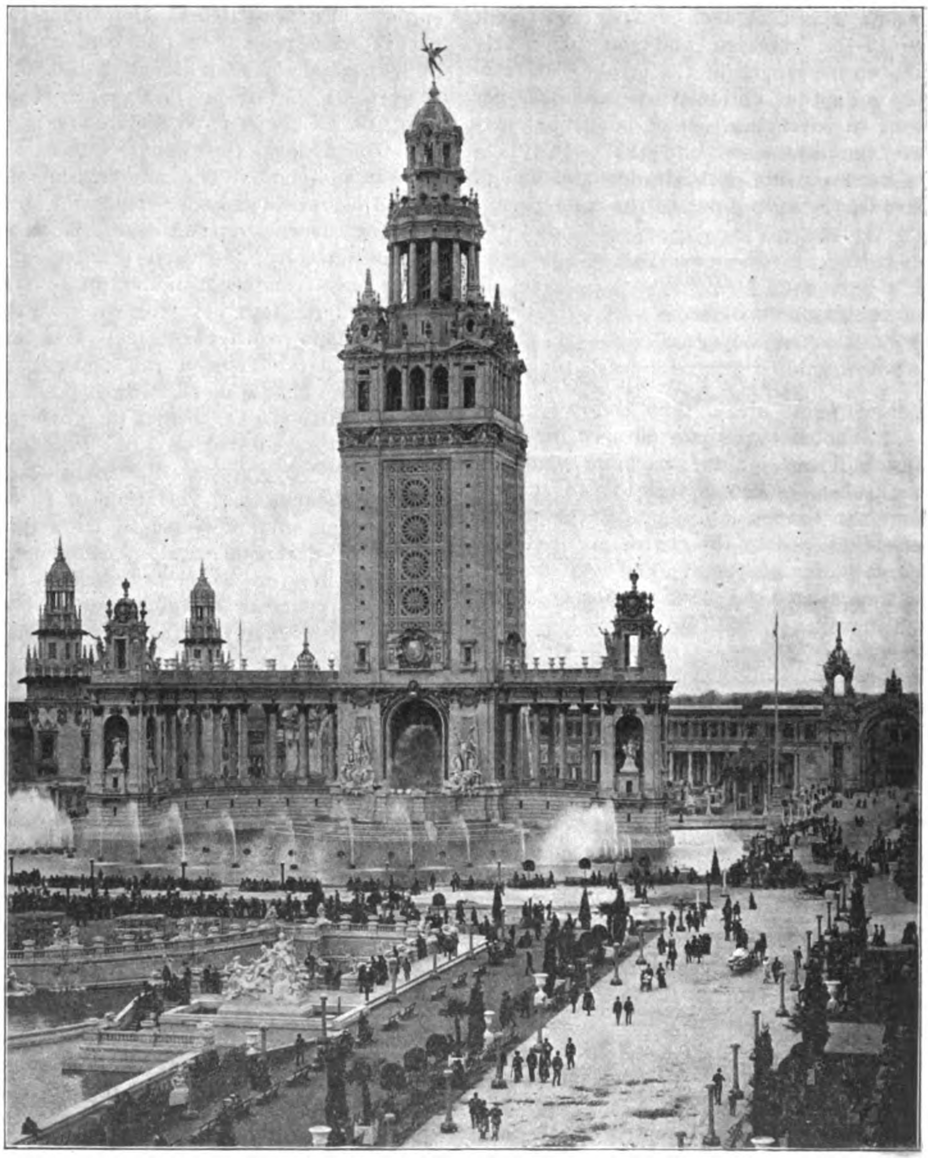
The Utilization of Waterfalls in Sweden.—An interesting report has just been issued by the Swedish Agricultural Department bearing on the subject of the utilization of the numerous waterfalls in the country for the development of motive power. It is pointed out that the national coal bill for last year amounted to 64,000,000 crowns and that this sum might be considerably diminished by the employment of the natural motive power possessed by the country. The available energy of the principal waterfalls in Sweden is estimated at from 2,000,000 to 4,000,000 horse-power. It is not stated whether these figures apply only to sites which may be developed at ordinary expense or include all practical water-powers.

Decorative Lighting at the Pan-American Exposition



INCANDESCENT lamps have been in use for decorative and outdoor illumination for a number of years past, but it is safe to say that the effects of the exterior lighting scheme at the Pan-American Exposition are certainly the most magnificent and probably the most artistic, that have ever been produced. The chief glory of the decorative illumination is the Electric Tower. This handsomely ornamented structure stands near the northern end of the grounds, in the center of one of the several basins, and the spectacle presented by the illuminated tower at night is simply beyond description; a feeble idea of its appearance is barely suggested by the head-piece of this article. Fig. 1 shows the tower by day. From a niche in the face of the tower pours a great volume of water which is broken into spray by a deflector and falls upon broad ledges from which it flows into an immense basin, in which are several fountains, jets of which rise to a great height.

By day the scene here is grand and inspiring. By night, when thousands of incandescent lights and a hundred searchlights illuminate the tower and its surroundings, the grandeur and inspiration are increased a thousand-fold. The imagination is too feeble to conjure up a true picture of the scene; one must see these changing colors upon the tower and water in order to appreciate the splendor. But the brilliant day and night scenes are not confined to the Electric Tower and its basin. One has but to turn half around to view another splendid sight, in the Court of the Fountains, with its profusion of sculpture and fountains. Here the water projected into the air assumes various beautiful forms, and at night all are under the play of vari-colored electric lights. The framing is superb, the great structures on all sides being aglow with electric light. About 40,000 lamps are used on the tower alone. An interesting experience, and one which visitors to the Exposition generally avail themselves of,



Copyright, 1901 by C. D. Arnold

FIG. 1.—VIEW OF THE ELECTRIC TOWER, BY DAY.

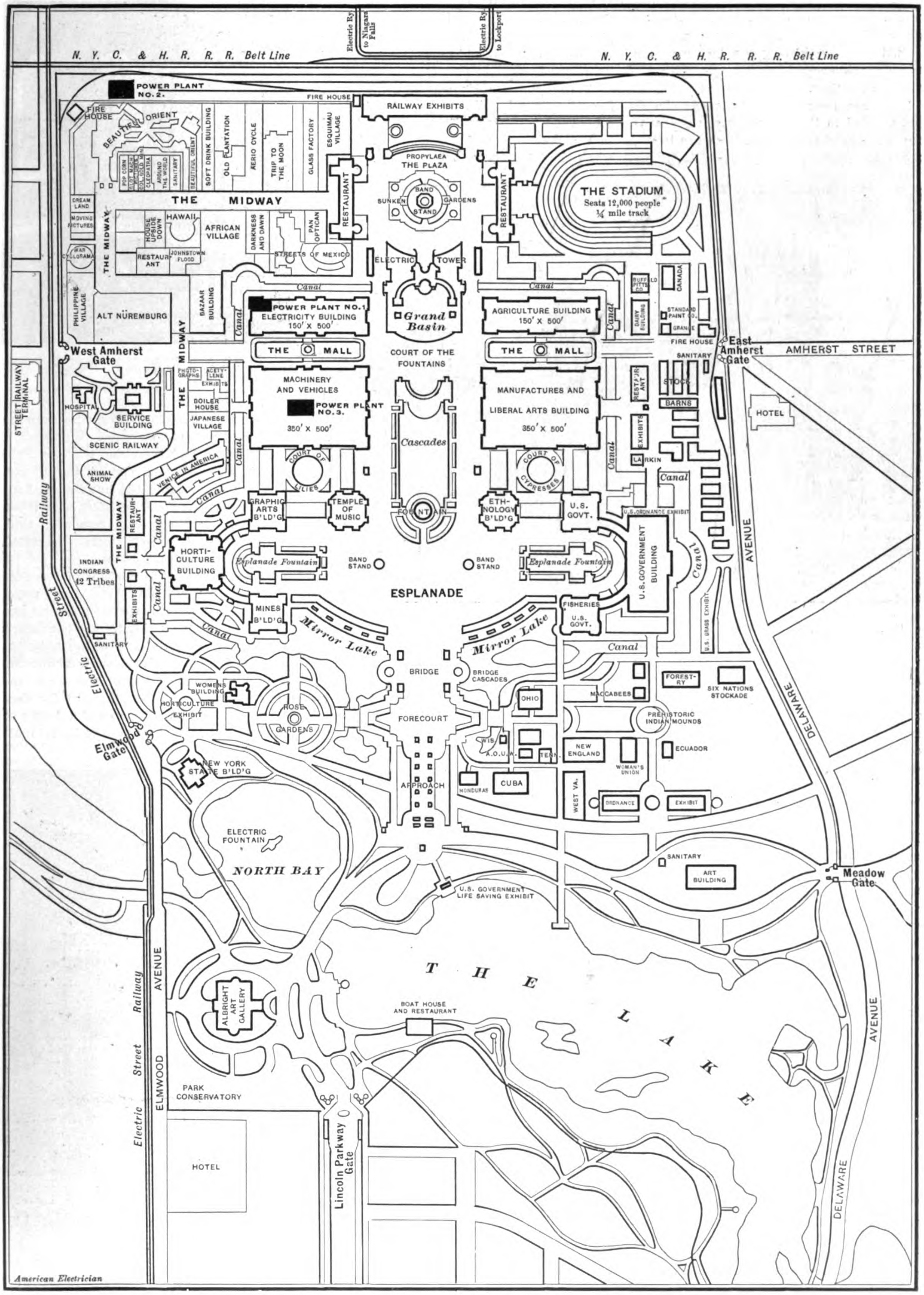
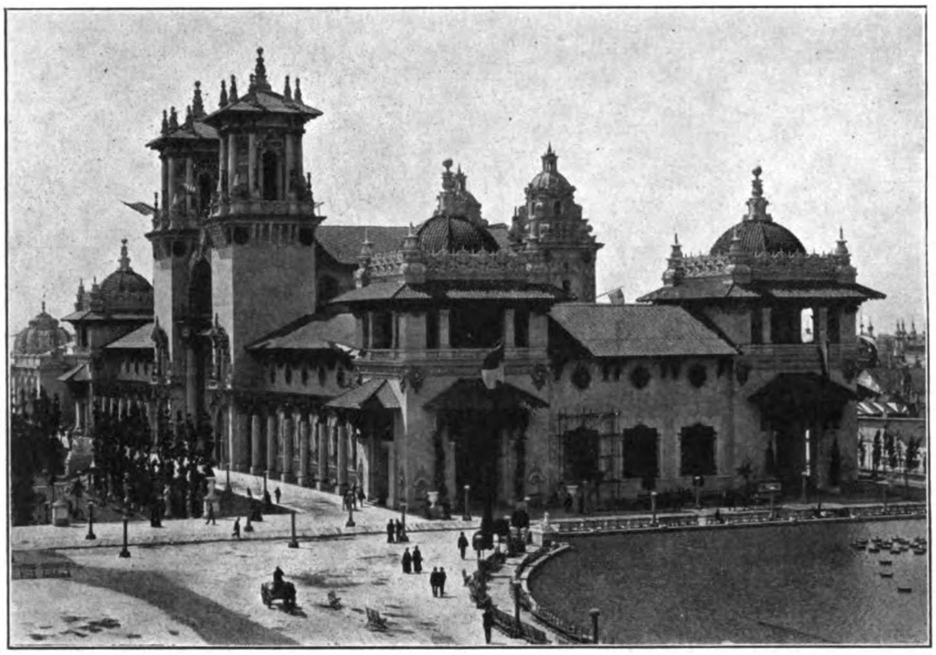


FIG. 2.—MAP OF THE PAN-AMERICAN EXPOSITION GROUNDS.

is the ascent of the Electric Tower. Elevators run to a landing 270 ft. above the ground, from which there is a grand outlook, the vision having a wide range for many miles around, sweeping the entire Niagara frontier.

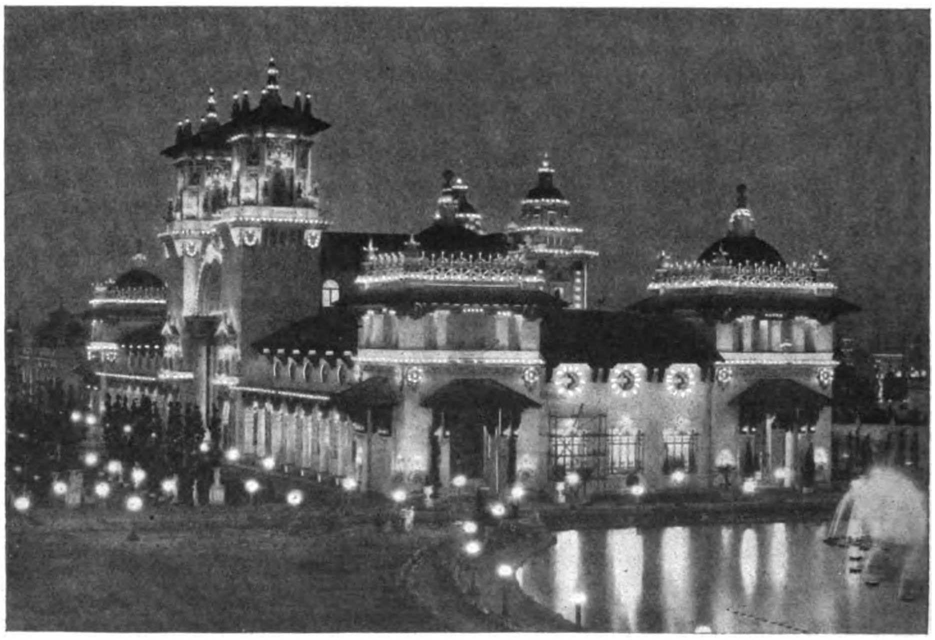
Much has been said in scientific circles and printed in the popular press concerning the "grand illumination" of the buildings and courts and grounds of the Pan-American Exposition by incandescent electric lamps. This illumination is now an accomplished fact, and a remarkable feature of it is that the predictions made concerning it were not extravagant. Indeed, it would be difficult to exaggerate the grandeur of the spectacle. As may be gathered from the various engravings herewith, the buildings are all etched in light against the background of the sky, after nightfall. The eaves, ridges, turrets, spires, domes, entrances, etc., are all outlined by 8-c.p. incandescent lamps studded at such close intervals that the outlines are perfect; there is not a single hiatus to be filled by the imagination, nor is there any blinding glare to mar the effect or create discomfort. The grounds are additionally illuminated by means of lamp clusters mounted on short ornamental pillars, two of which are shown in the head-piece and a third in the initial cut herewith.



Copyright, 1901, by C. D. Arnold.

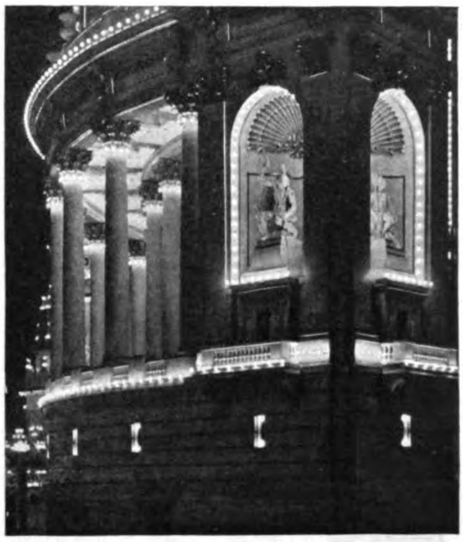
FIG. 3.—DAY VIEW OF ELECTRICITY BUILDING.

The week preceding the opening of the Exposition was a memorable one to the men engaged in the electrical bureau of the Exposition, for during that time preliminary tests of the illumination of the Electric Tower and several of the buildings were made. These tests were equivalent to rehearsals, and the men who had been building for months awaited the turning on of the lights with breathless anxiety. In the one setting there were shown the Machinery and Transportation Building, the Manufactures and Liberal Arts Building, the Electricity Building, the Agriculture Building, the Restaurants, the Sunken Gardens, the Propylaea, and in particular the great masterpiece, the Electric Tower. It was the first time the tower had been lighted to any extent, and even then the illumination was not complete; the lamps were set aglow from the base to a high level where scaffolding stood to aid in the erection of the Goddess of Light, which had just been put in place. (Incidentally, if the Goddess of Light had life and could express an opinion, there is little doubt that it would be an expression of pleasure in serving as the apex to an effect of such regal brilliancy and splendor.) When the first illumination occurred, the darkness of night was intensified by a spring fog. Men stood in front of the Electric Tower who remembered the first incandescent illumination of Louisville, had seen the World's Fair at Chicago, and had visited the recent Paris Exposition, and the unanimous verdict was that the lighting effect here must surpass all previous achievements; that this prediction has been amply vindicated there is not the least doubt.



Copyright, 1901, by C. D. Arnold

FIG. 4.—NIGHT VIEW OF ELECTRICITY BUILDING.

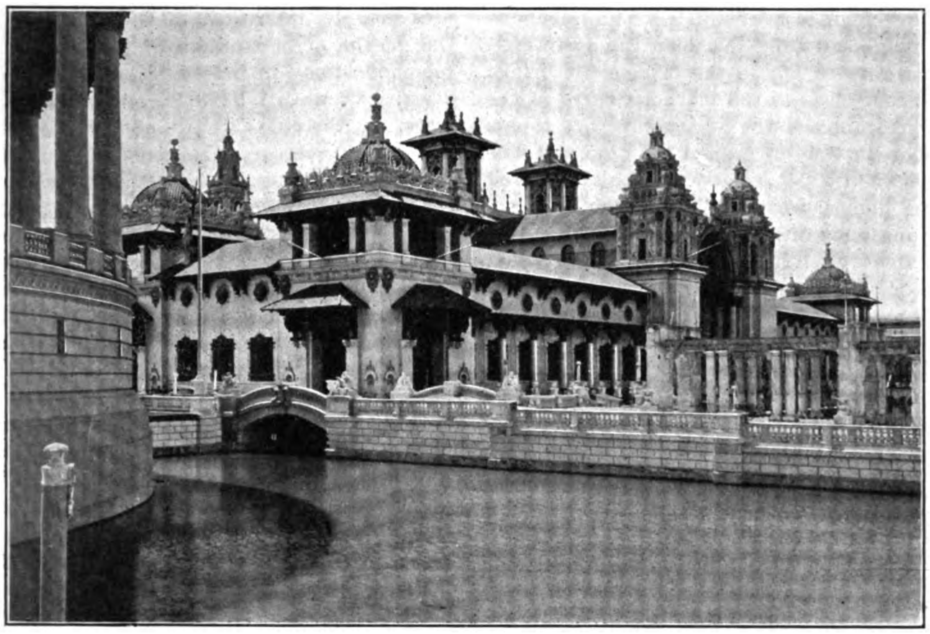


Copyright, 1901, by C. D. Arnold

FIG. 5.—A BIT OF THE TOWER AT NIGHT.

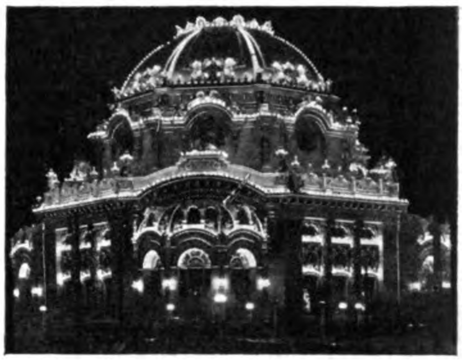
The most distinctive feature of the decorative lighting, aside from the great amount of power so expended, is the use of 8-c.p. lamps throughout. Arc lamps are used only for service lighting in the buildings and in semi-isolated spots about the grounds. The selection of the 8-c.p. incandescent lamp as the standard for decorative lighting was because of a desire to suppress as far as possible the individuality of each lamp and give the general effect that of areas and lines rather than points of light. The result is an impressive lesson in artificial illumination, being an incontrovertible demonstration of the superiority of many small units over fewer greater ones. An impressive effect is produced every night by turning out all of the lights and then very gradually bringing them up to full candle-power, the process being carried over a period of about 15 to 20 seconds. This is accomplished by means of a huge water rheostat inserted in the primary circuits of the transformers through which the energy passes to the lighting circuits.

The general scheme of the main area lighting depends for its success on the arrangement of buildings with reference to the Electric Tower. There is a gradual increase of luminosity beginning at the south end of the court, until it reaches a climax in the stately Electric Tower at the north end, where the lights are clustered the thickest. The number of lights and the quantity of light exceed that of any other equal area before artificially illuminated, and, as mentioned above, the light is evenly distributed. When one considers that nearly 150,000 incandescent lamps are used for the decorative illumination of the grounds and buildings, requiring for their maintenance about 6000 horsepower, one begins to realize that the fairy-like scene which contributes so much to the attractiveness of the Exposition has a very real, prosaic and costly basis. The results, however, fully justify the expenditure, as the effects are truly wonderful and beautiful, and of a kind never before seen.



Copyright, 1901, by C. D. Arnold.

FIG 6.—ELECTRICITY BUILDING, VIEWED FROM THE GRAND BASIN NEAR THE TOWER.



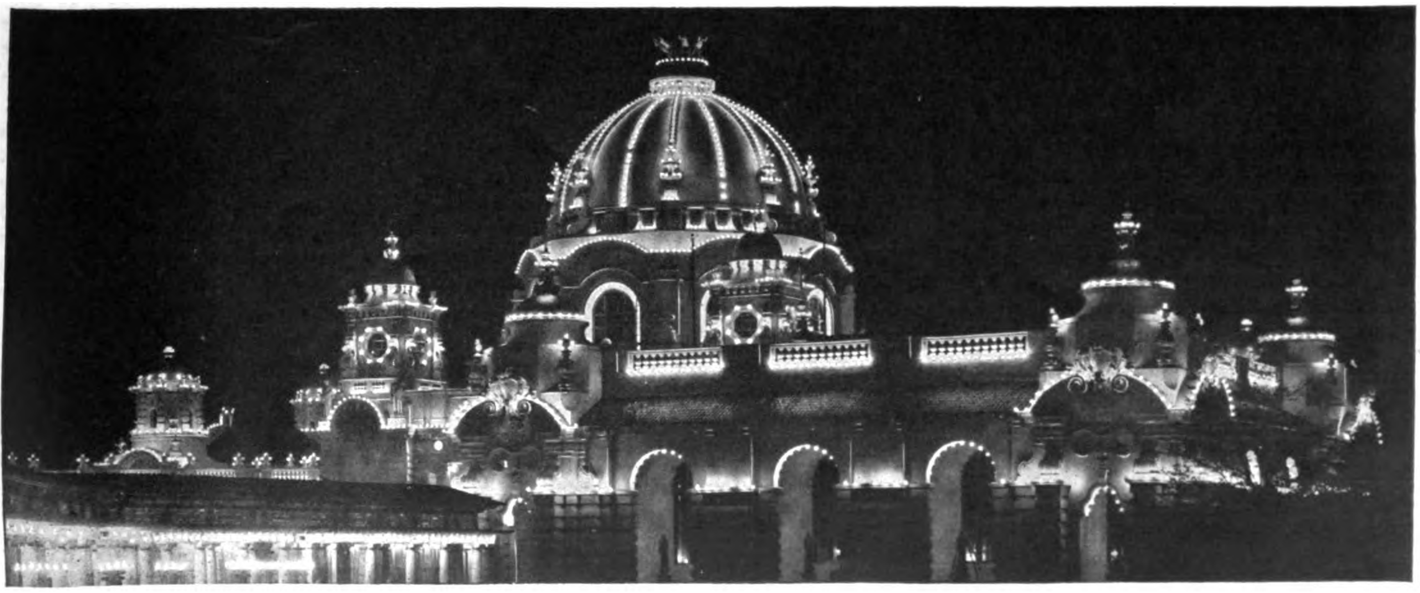
Copyright, 1901, by C. D. Arnold.

FIG. 7.—A HANDSOME EFFECT.

OTHER FEATURES OF THE EXPOSITION.

Next in importance in electric decorative effect after the incandescent lighting of the main area and buildings must be mentioned the electric fountains. In the grand basin in front of the Electric Tower are 100 searchlights for use in connection with the fountains, but the main electric fountain is in the North Bay. The fountains in the basin take 500,000 gals. of water an hour for their full operation. The fountain displays in the large court follow the same idea as the lighting and reach a climax in the basin below the Electric Tower. In the semi-circle around the "Fountain of Abundance" a bed of beautiful flowers is to be illuminated so as to bring out all their delightful colors. The lamps for this purpose will be concealed. The island in North Bay on which the principal fountain is located is 160 by 80 ft., and stands 10 ft. above the water level. The main geyser jet is designed to throw a 1½-in. stream 250 ft. high. Around the central jet are 102 fountain orifices and 22 holophote orifices. The 22 searchlights used under the latter were made by Chas. J. Bogue of New York, and are 22-ampere arcs. The pumps for the fountain are electrically operated and located in the chamber beneath the fountain.

Among other spectacular effects which are being prepared, signaling by searchlight from the Electric Tower to Niagara may be mentioned. The plan will serve as an object-lesson to the public of how searchlight signaling is done in the army. A 30-in. 80-ampere projector of General Electric make has been installed for this work at the 360-ft. level of the Electric Tower, and another will be put in Observation Tower at Niagara Falls. The installation of a searchlight at such a height with clear country around will give unusually good opportunities for studying its effects at a distance. In this connection may be mentioned the lighting of Niagara Falls themselves by searchlights placed on the banks during the Exposition. The preliminary experiments are reported to have been most satisfactory, and visitors to Niagara at night can hereafter enjoy something unknown to former generations.



The Independent Telephone Convention.

The fifth annual convention of the Independent Telephone Association of America was held at Buffalo, June 11, 12 and 13. The meetings were held at Convention Hall, about a mile from the Iroquois Hotel, which was the headquarters of the delegates, and the convention seems to have been a record-breaker in point of both numbers and enthusiasm. The convention was called to order at noon on June 11 by President J. M. Thomas, who introduced Mr. Conrad Diehl, Mayor of Buffalo. Mr. Diehl welcomed the delegates to Buffalo and delivered appropriate remarks relative to the industry which the convention represented.

Judge Thomas then delivered the presidential address, in which he pointed out that the past year had been marked by events of unusual importance in the telephone world, and had demonstrated that all doubt of the permanency of the independent telephone movement has passed. He reviewed the history of the electrical development of the modern telephone system, and pointed out that if the Berliner patent, issued in November, 1891, or the Edison carbon transmitter patent, issued in May, 1893, had been sustained, the Bell monopoly would have continued until 1908 or 1910. He then related how the Berliner patent came to be attacked by the government for the purpose of testing its validity, and how the Edison patent, though valid, was held to have expired prior to the natural date of its expiration because of the expiration of a foreign patent covering the same transmitter. Judge Thomas paid tribute to the efforts of those interested in independent telephone work, notably, Messrs. Milo G. Kellogg and J. B. Leatherbee, who had devoted much time and energy to the litigation referred to, and suggested that acknowledgment was due them from the association for their work in this direction. In conclusion, Judge Thomas stated that the independent companies, having proven their legal right to give telephone service by good and efficient methods and having demonstrated their ability to compete with the Bell Company, it becomes now a question of working together for the common good, and it is important that at this meeting such questions should be considered as will lead to unity of action.

At the close of the president's address the convention unanimously passed a motion by Mr. H. D. Critchfield, general counsel of the Cuyahoga and U. S. Telephone Companies of Cleveland, to adopt the suggestion of the president and extend the thanks and grateful acknowledgment of the association to those who had so faithfully and enthusiastically guarded its interests in this great litigation.

SECOND DAY'S PROCEEDINGS.

On Wednesday morning, June 12, a paper was read by the Hon. S. P. Sheerin, of the New Long-Distance Telephone Company, of Indianapolis, on "Village Exchanges and Farmers' Lines."

The telephone, said Mr. Sheerin, is a greater boon to farmers than to any other class of people. The great drawbacks of country life are its isolation, its meager opportunities for social intercourse and its still fewer opportunities for protection. When we add to these the disadvantages of being out of touch with the market, and out of reach of the great news pulse of the country, the sum of the country life's shortcomings is complete. The telephone changes all this. No man can fully estimate its benefit to the farmer. It brings his ear close to the market tickers of the world; brings the weather report to his door, in time to protect his crop and cattle, and travels, what would be to him and his horses, weary miles, in the ordinary transaction of his every-day business.

It is a slight reflection on the usual good sense of the average farmer, who has progressed in other respects out of the cheap way of doing things, to find him insisting upon putting up cheap, grounded telephone lines, on native poles three or four hundred feet apart—marring the landscape and furnishing temptations to profanity by those who have to use them. A poorly constructed and badly managed country telephone line is many hundred times worse than no telephone at all. There was a time when those things served their purpose as educators, but that time has passed.

The country telephone lines (and all other telephone lines which go along the country road) should be considered as part and parcel of the road itself. They should not be considered as tenants of the road, or as something that is there by sufferance, or by the permission—grudgingly given—of those who, for the time, do not appreciate its advantages; but it should be regarded as a part of the road itself.

Mr. Sheerin said he looked forward to the time when telephone lines will be regarded as such sacred property that men and boys will no more think of interfering with a country telephone line than they do now of throwing stones at windows or killing song birds as they pass along. In order, however, to be entitled to this high regard from the public, the telephone system must by its outward appearance command the respect of the people. Telephone lines should be substantially and neatly constructed. They should be of the very best material—good, heavy, well-shaped poles (no pole shorter than 25 ft., nor smaller than 6 ins. in diameter at the top); cross-arms should be of regular length and the wires supported in a thoroughly mechanical manner. As time goes on, and our high regard for the telephone increases, we may get along with shorter poles, and put out wires as near to the ground as electrical conditions will permit. We may not have to use very high poles anywhere, except at road crossings, and it is barely possible that we may reach a condition where it will be found easier to go under crossroads than over them. Wherever it is possible, not more than one line of poles should occupy the same side of the road. It will be entirely possible to build a line, sufficiently strong and symmetrical, to take on all the lines that should go along any particular roadway.

Of course it goes without saying, that all lines should be iron or copper, metallic circuit, and the maintenance of the whole line should be under the control of one head as nearly as possible, without reference to how many persons or companies may be interested in the pole line. One of the great troubles of the country telephone line—as, indeed, it is one of the drawbacks we all have in cities—is the trees. In the cities we are able to escape this annoyance very largely by the use of cable, but, of course, it would be impossible to do this in the country. Not taking into account the great additional cost of that sort of construction, there are electrical considerations that make a continuously long cable line an impossibility. The trees on the country roads should give way to the telephone. Trees along highways, near residences, can just as well be set back 25 or 30 ft. They have no business on the highway or overlapping the highway, when they interfere with the uses of the highway. The telephone is a proper use of the highway. In many respects it is the most important use.

Village exchanges should be encouraged everywhere, and these village exchanges should have direct communication with the county seat exchanges and the exchanges in other towns of the county; and these exchanges, in turn, should be connected with the long-distance exchanges of the several States.

With all due respect to the manufacturers—and they are entitled to a great deal of credit for the development of the telephone business—they are very largely responsible for a great lot of shoddy, inefficient and wholly abominable telephone equipment in the country. They go upon the theory that the farmer wants something cheap, and that the way to catch him is to present a very low-priced article, without very much reference to how long it will last or what service it may give him in the meantime. This is little short of criminal, and cannot be too strongly condemned.

This association, and all other people largely interested in the telephone business who want to escape responsibility for bad service by other people, as well as by themselves, should set their faces firmly against the manufacturers who make specially "Cheap John" equipments for farmers' lines.

The battlefield of the great telephone war, which has been raging in this country for the past five years—with the victories always on the same side—has been largely transferred from the cities to the country. The Bell companies, in the days of their monopoly—and, in fact, until quite recently—positively refused to furnish service to the farmer upon any terms. Now they have changed their minds about that, and seem to have concluded that the farmer and the villager are not such bad fellows after all. But their repentance has come too late.

In the discussion of Mr. Sheerin's paper, Mr. J. B. Ware, of the People's Telephone Company, Detroit, Mich., pointed out that the distinction between farmers' telephone service and the usual class of service had not been recognized. Some farmers used their telephones for business purposes, he said, and were desirous of having individual lines, but the principal farm telephone service was based on sociability, and he had been surprised to hear an experienced man say that usually the farmers would rather have six on a line than not. In fact, if an exchange in a farming district had six telephones on a line, he could go into the same territory and take all of the business by simply putting 20 on a line. In some places farmers had built their own lines, connecting up their own systems to cheap instruments and switches, some one farmer allowing the central switchboard to be installed at his house, and the farmers were getting their service for nothing. It was difficult to build up a toll-line business in the face of such conditions, and they were a menace to telephone development at the hands of some of the independent companies. In Michigan $12 was the limit for farm service, and some rates were even lower, but in the long run farming communities would outgrow this condition and demand more separate lines, or party lines with at most only two or three instruments connected up. This means that the present pole lines with six-pin cross-arms will become inadequate, and the companies should even now put in poles to carry 10-pin cross-arms with a view to increasing the number of circuits. This change would be the salvation of the telephone industry in Michigan and elsewhere, and the consequent high rates, he thought, would not be opposed.

Mr. Fisher called attention to a court decision in Ohio ruling that telegraph, telephone, electric light and street railway companies having proper franchises could remove trees or parts of them which were an interference with the reasonable use of the highway for purposes of traffic and commerce.

Mr. T. J. Fricker, of the Ashtabula Telephone Company, delivered a rather lengthy but humorous discourse on the relations between the independent telephone companies and the farmers, in the beginning of which he referred to a case in Michigan similar to that mentioned by Mr. Fisher, where the courts had held that public service companies have the right to cut any branch of a tree that interferes with the carrying out of the object for which their franchises have been granted.

Mr. Chas. E. Wilson, of the Keystone Telephone Company, Philadelphia, who had been asked to read a paper on "Independent Telephone Development East of the Alleghanies," apologized for his inability to prepare it owing to work on his new exchange, which will be in operation by October. He then gave some interesting information concerning the new exchange. The conduit and cable system has been laid out for a capacity of 30,000 instruments with all underground connections, and there will be two main buildings. About 4000 five-year contracts have been signed and contracts are still coming in at the rate of 75 to 80 a day. The company had been advertising in local papers to the extent of $2000 a month, but although this has been discontinued, subscribers are coming in just as freely as before. Kellogg switchboards will be used, and the telephones will be manufactured under contract from specifications of the company's own engineers. The rates will be $80 for a single business line; $52 for a two-party line; $48 for a single residence line; and $36 for a two-party residence line.

"Telephone Development East of the Alleghanies."

Senator C. W. Kline, of Hazelton, Pa., president of the Interstate Telephone & Telegraph Company of Pennsylvania, then read a short paper on the subject which had been assigned to Mr. Wilson. He said that under the excellent management of Mr. S. E. Wayland, fine exchanges had been built in Scranton and Wilkesbarre, covering the Lackawanna and Wyoming Valleys, with 7000 telephones now connected up, and a possibility of over 20,000 more in sight. Allentown, the center of the Lehigh Telephone Company's system, has a splendid system, with a possibility of 5000 telephones, with about 1800 installed. Reading is being built. Easton is working up the lower Lehigh. The Overland of Lehighton reaches out for everything in sight. The Anthracite, of Hazelton, embraces everything in lower Luzerne, Upper Carbon and Northern Schuylkill counties. The Standard, of Bucks and Montgomery, is now being rebuilt by Mr. G. S. W. Brubaker, covering all that section. The United Telephone companies embrace Norristown, West Chester, Lancaster, Lebanon, all of the Schuylkill, Northumberland, Montour and Columbia counties, and the north and west branches of the Susquehanna. York connected with Carlisle via Chambersboro is extending its lines in every direction in York and Lancaster counties, and is connected west to the Alleghanies. As to New York State, he remarked that fine plants had been installed at Rochester and Albany. The United Telephone Company, of Pennsylvania, covered the southern portion of New York State. The Maryland Telephone & Telegraph Company had a splendid plant at Baltimore, and the chain of independent companies stretched south along the Atlantic to the Gulf of Mexico.

As to toll lines, Mr. Kline said that they were "short" on those, and "long" on local exchanges. But already the Interstate Telephone & Telegraph Company had built lines in the eastern portion of Pennsylvania connecting up that entire region with some 14,000 telephones, and it had its terminal at Trenton, N. J., thence reaching over the lines of the State Telephone Company, of New Jersey, up to Jersey City, which meant New York. The Interstate Company was also ready and willing to reach out across the Alleghanies and make the chain of service complete between east and west. There were at present too many companies in the field ambitious to control the situation as to toll lines, but in due time they would have to poll their interests and bury their differences. From the independent standpoint, the situation east of the Alleghanies was excellent, and with 50,000 instruments they meant to take the "right of line" in the movement, and stay there.

Mr. C. E. Stinson, of the Rochester Telephone Company, gave an interesting account of the development of the system in Rochester. The company has at present 3600 telephones in service in a population of 160,000. It has 160 miles of pole line and covers all the territory within a radius of eight miles from Rochester. At the close of Mr. Stinson's remarks the session adjourned until Thursday morning.

THIRD DAY'S PROCEEDINGS.

The Thursday morning session opened with a paper by Mr. L. W. Stanton, switchboard manager of the Cuyahoga Telephone Company, Cleveland, on

"Exchange Service."

The independent telephone interests are to-day in greater danger on account of some of the inferior apparatus that is being thrown upon the market than they have ever been from the old monopoly. Some of the apparatus that is being sold to-day by the independent manufacturers is a curse to independent telephony. It only half works. It is unreliable, it does not give good local service, not to mention the poor results obtained when used for long-distance lines. Every telephone that is installed to-day should be one over which conversations between New York and Chicago can be carried without difficulty, for it is only a matter of a short time till every telephone in this broad land will be connected by a network of long-distance lines to every city, village, town and hamlet. The continued use of inferior apparatus will mean unreliable service, poor transmission, expensive maintenance and a final discarding of the original installation at a great loss, and, worst of all, dissatisfied subscribers. It is true, it is difficult for the independent telephone companies to select the best apparatus, for, as a rule, their experience has been limited to the use of apparatus that was furnished them a few years ago. Another reason is the unparalleled strides that have been made in telephone manufacturing within the last few years. They have been accustomed to the old magneto drop board, which is undoubtedly a thing of the past in exchanges of any size. In any exchange of over 100 subscribers, where suitable arrangements can be made for current, the only thing to install is a central energy lamp signal board with double supervision.

Wherever an exchange requires three or more operators a multiple board should be installed, for when transfers are used they impede the service and add permanently to the operating expense. On a large transfer board, you almost double your work, for nearly every call has to be trunked to a second operator, while with a multiple board each operator handles her subscribers' calls direct, without assistance. Another distinct advantage of the multiple board is: One operator in the evening and on Sundays can sit at one position and answer all calls through the multiple. In this way, with double supervision, she has control of the entire board. This class of apparatus is superior because it gives better service and is cheaper to operate; first, because it requires fewer operators; second, because it dispenses with hundreds of local batteries scattered over miles of territory; third, it does away with an expensive piece of mechanism, the generator, with its cog-gears, shunts, commutators, etc., which are a constant source of wear and tear; fourth, in eliminating the generator and batteries, the number of inspectors can be reduced, which is no small item.

The following figures will give some idea of the saving in the cost of current for an exchange of 1000 subscribers. Taking the cheapest form of battery, which is the dry cell, at 15 cents each, and using two cells per telephone, which is modern practice, there is a cost of 30 cents per telephone. Allowing the battery a life of one year, which is more than the average, we have a cost of $300 a year, or $25 a month for the 1000 telephones. In a central energy exchange of something over 1000 subscribers the average cost of all current for operating line signals, supervisory signals, and all current used for talking, amounts approximately to $6.50 a month, which is about one-fourth of the cost of current for operating the same sized system with local batteries, to say nothing of the additional cost of labor for renewal and maintenance.

From a number of monthly reports of trouble covering both common battery and magneto type exchanges, Mr. Stanton found that the number of cases of trouble at the subscriber's instrument is from two to four times as great for local battery plants as it is for common battery plants. With one of the latest types of central energy telephone the trouble at the subscriber's station is reduced to a minimum. There is practically nothing left but the transmitter, receiver and signal bells, and these, as they are made today by some of the best manufacturers, almost eliminate the possibility of trouble. This coupled with accurate and scientifically constructed apparatus at the central office, gives the ideal system, and it is only with an ideal system we can give ideal service. It is often remarked that it requires better line construction for common battery plants, but any good line will work well with common battery, and in some cases this system is worked on a common return.

Telephone men are beginning to realize the importance of good line construction, especially when they see the great difference in the expense of maintenance between well and poorly constructed lines. The Bell Telephone Company's plant in St. Louis, in whose employ the writer spent several months in different departments during the building of their new common battery exchange, offers a good example of first-class construction. In building this exchange they were extremely particular that every detail be carried out in the best possible manner. The entire system was put in so that it would stand the test of time. The interior wiring was protected in every possible way. Telephones were placed on the wall in the most substantial manner. Cable work and line construction were unequaled. As a result, the number of cases of trouble per telephone is less than that of any other telephone exchange in the country. The parent company has awarded them the credit of giving better service than that given by any other licensed company, and in the face of the strongest competition it is understood that their financial showing is very good, which would not be possible with slighted details and poor construction.

Look through the operating rooms of some of the large Bell and independent companies and notice the number of idle operators, while on the same boards there are operators that have more calls than they can properly handle. Few telephone men seem to have realized the importance of equalizing the load among the operators, that is, placing enough lines in front of each operator to properly load each position.

The operating force of a large exchange is one of its most important factors. If the operators are well disciplined and courteous, the subscribers are quick to notice and show their appreciation. Even a second or two is noticeable to a subscriber when awaiting an answer from central, and on hearing the operator call "number" in a brisk, clear tone, with a rising inflection, it conveys the idea of discipline. But if the operator answers with a falling inflection and uncertain voice, it gives the opposite impression; in fact, the operating force is nearer to the telephone public and wields a greater influence among telephone users than any other class of individuals connected with the company. It is through the operators that we dispense the little courtesies which make our service popular.

There are few managers who realize the great advantage to be derived from the proper training of their operators. As a general rule, an operator after being employed is given a seat at the switchboard beside one of the old operators, and is told to watch the other operators and learn what she can, and in a short time she commences to answer calls, and from that time on she is supposed to be an operator. As a matter of fact, she is far from being one. She should become thoroughly familiar with all the rules, and should have their meaning explained to her. She should be taught how to handle the plugs with the left hand as well as the right. Until she can use her left hand as easily and naturally as her right she is only half an operator. She should be taught how to answer two and three calls at the same time without interference. It is only in this way that an operator can answer quickly and handle the number of calls that she should. Walk through almost any operating room, especially that of an independent exchange, and notice the number of "wooden arms" and "mallets" that are in use. Notice the number of false moves and untrained voices, and you will realize that the company is spending unnecessary money. By "wooden arms" is meant that the operators do not use the left arm any more than if it were wooden. By "mallets" is meant that they are driving the plugs in by the heel of the hand, breaking the tinsel of the cords, causing a cut-out, which means unsatisfactory service, besides the expense of replacing the broken cords. By false motions is meant that the plug is picked up with one hand and passed to the other instead of being inserted with the hand with which it was picked up. These are only a few points in which operators should be trained.

The operating room should be conducted on a merit basis, and promotions made according to the efficiency and courtesy of the operators. During each month competitive tests should be made to determine the speed and courtesy of operators in answering subscribers, and those having the highest general average as regards speed in responding to calls, courteous treatment of subscribers, obedience to rules, promptness in reporting for duty and regularity of attendance, etc., should receive some sort of promotion. Those who through these tests prove to be unqualified for the position of operator should be discharged. A form of promotion which has been found to work well is to give the operator having the highest general average the most desirable hours, and those least efficient the night hours. Another reward of merit which works well is to recognize an operator's ability by giving her a small raise in wages, say $1 at a time. This may seem like a small amount, but by giving a small raise at each time you can reward their efforts more frequently and thus get better results. Another method which works admirably is to arrange each operator's merit standing, showing who is first, second, third, and so on, leaving a copy in their recreation room. This starts a friendly rivalry among the operators, which produces results that cannot fail to make our service popular.

Every large operating room should be presided over by an A1 telephone man, who is thoroughly acquainted with every detail of the business, and who realizes the necessity of prompt action in the trouble department and the proper disciplining of the operating force. Last, but not least, he should have the faculty of dealing with the telephone public.

Mr. Stanton said that a girl could easily take care of 2000 calls a day. In Chicago, the Bell exchange count from tests over a series of five years, showed a possible 528 calls per hour. The figures from leading Bell exchanges showed that one-eighth of the number of calls in the 24 hours gives the peak of the load. The result would be something like 4000 calls per 24 hours. Of course, with the old magneto board it took six times as long as with modern multiple boards, especially when modern plants included intermediate boards. It is absurd to put only 100 subscribers in front of each operator.

After some discussion on Mr. Stanton's paper, the Hon. E. B. Fisher, of the Citizens' Telephone Company, of Grand Rapids, Mich., read a paper on

"Bell Methods."

Mr. Fisher pointed out that the Bell Company's exchanges throughout the country have for years enjoyed the interchange of opinion and experience and through the advantage of such interchanges have avoided many difficulties and secured many improvements. The independent companies can and should copy this method. The Bell Company, although composed of many subordinate companies, has been in a sense one family. The independent companies can retain their individuality, maintain their ambitions to be first in their sphere of action, and still remember that they are a part of one family. Some have been inclined to suggest that the Bell Company had too much system. As the business develops it begins to develop that too much system is less expensive and less foolish than too little. In systematizing business the independents have much to learn from Bell methods.

Six years ago, when the canvass was begun for money with which to build the plant of the Citizens' Company in Grand Rapids and for prospective patrons, representatives of the Bell Company asserted confidently that the telephone plant would never be built; indeed, that the independent company had no intention of building a plant and was only trying to make money by being bought out. The company has been giving service for more than five years, and has grown until it now has in service more than one-half the number of telephones that the Bell Company had in the entire State of Michigan five years ago, and yet to-day similar predictions and commentaries upon other independent enterprises are indulged in by Bell representatives. If you get started with the service and find that your patrons are receiving circular letters suggesting that Bell is owner of letters patent number so-and-so, and that all who use independent apparatus infringe such letters patent are liable to prosecution, do not flatter yourself that in this method the Bell Company is distinguishing you beyond other independent companies. Such things have been done repeatedly, but you have yet to hear of a subscriber who has been prosecuted, and you can safely guarantee your patrons against any damage that may be awarded by any court under such suits, and agree to pay all expenses for defense.

If the Bell Company has frequently informed the people in your community that its former rates were the lowest it could afford to make in your locality and has, upon the development of your competitor, resorted to free service, or service at rates much less than cost in an effort to destroy you, do not imagine that such practice can really damage your company. Begin the education of your patrons, take the people into your confidence, tell them the truth about your business and its results, insist upon a fair profit, upon reasonable returns on the actual investment, after giving good service, and you will find the people ready to pay your price rather than to get absolutely free service from your competitor. Do not resort to other tactics because there can be but one result. The company which reduces its rates below a reasonable point in the struggle with the Bell Company is doomed the moment it does so.

Referring to party-line service, Mr. Fisher said that his observation had been that party-line service is largely a snare and delusion for city exchanges, and is a form of competition that need not be feared by independent companies, notwithstanding the fact that the president of the Central Union and the Chicago Telephone Company (Bell), who is a man of extended experience and wide observation, is a stanch advocate of this sort of service. No devices have yet been invented which will permit more than two parties to use the same line at the same time, so when any pair on a party line holds the line others must wait. Referring to minute rates for toll service, he said that in Michigan independent companies had not quite decided as to its present and probable effects. On general terms, it is fair to state that it is causing considerable friction and dissatisfaction. The average telephone user is ready to affirm that he has not used the service as long as he has been charged for, and believes that the minute rate is intended to thus increase the fees of the telephone company, which he was inclined to believe were already quite large enough. If the average business man on a long-distance connection can actually accomplish his conversation in a single minute, the line cannot earn enough at the price for one-minute connection because quite as much time is usually spent in getting two parties to talking as is occupied with their conversation. If the time for securing connection cannot be reduced and the time of use is reduced with theoretical reduction of pay, the service would be less profitable to the companies than one based on three or five-minute connections. If the average subscriber is expected to use the line on a three or five-minute basis, why not make rates upon that theory?

In Michigan the Bell representatives have taken a new departure within the last few weeks. The independent telephone companies have been attempting in some instances to secure toll-line alliances with companies formerly built and still continued, as far as exchanges are concerned, as independent companies. The new policy of the Michigan Bell people is, in effect, to urge the independent companies to keep their local exchanges and even their own toll lines; take care of their exchange business in their localities, but enter into a contract for toll connection outside their territory through the Bell system. This system promises equal percentages on originating business, together with more extended and superior toll-line facilities. This late Bell method is insidious, and it is not strange that in some cases it is successful. The strong independent companies with considerable toll-line facilities, which have been growing, have not been influenced by such propositions; only the smaller and weaker companies have made such toll-line contracts with the Bell Company.

The Bell habit of ignoring the farmers—the small village and the country—has been an error. In this department of telephone service a proper development of party lines may be made with great advantage to the communities served and with fair profit to the investor. There are regions in Michigan—and probably each member could repeat the same tale—where the Bell Company is beginning to compete with independents in their own field in this regard. This Bell method of following a good example may prove a formidable competition and may materially strengthen the smaller Bell exchanges and their situation if they shall first enter new territory with this sort of service.

The rewards among the employees of the Bell heretofore have not been great either in salary or opportunities. They have been made to feel more like machines than human beings. In many cases they have not had their inventive tendencies encouraged by proper compensation for what they produced; indeed, they have been compelled to part with their inventions on the theory that their brains as well as their labor belonged to their employer, or because there was but one market for their invention and devices. That market could set its own price upon what it bought. Such conditions are not conducive to loyalty, or to inducing energetic service. The independents, if they shall copy Bell methods in this respect, will make a grievous mistake.

If you should wake up some fine morning and hear that you have sold, or are about to sell, your telephone plant to the Bell Company do not consider that the transaction is necessarily closed. If you hear similar reports as to actual or impending sales of other independent companies in your own or other States, be not disturbed thereat, nor convinced that the news is reliable. There have been some such sales, but vastly more rumors of those which never have occurred and do not seem likely to. There have been methods in these rumors. For some reason, some interest, evidently not independent, has believed it desirable to circulate such reports, probably in the hope that other independent interests might be disquieted or discouraged, and yield more readily to apparently advantageous offers. These methods have been relied upon to produce serious effects. Keep yourself and your neighbors advised of the strength and growth of the independent movement, of the strength of their own situation in competition, and fewer such rumors will be verified hereafter.

After a discussion of some routine business Mr. H. D. Critchfield delivered an eloquent address on

"Legislation and Litigation."

At the opening of his address he stated that he should have opposed an open discussion of these topics, as furnishing information to the independent companies' adversaries. Referring briefly to the subject of right of way, he said that, broadly speaking, the legislature had no power to give a company the right to put poles and lines on the highway unless subject to the limitations which are always upheld for the protection of property. If damage was done, it must be judiciously determined, and it was well to be as diplomatic as possible in obtaining rights of way. Regarding taxation, he stated that the valuation of telephone property at 60 per cent was entirely unfair, being three or four times as much as was paid by railroads and electric light companies. Action should be taken to correct and equalize this wherever necessary.

Mr. Critchfield then referred to the new president of the Bell Company as one of the ablest men in the country, and stated that it was his intention to change the policy of the Bell Company, so that connections should be made between it and the independent companies where the independent companies had the best of the position. There could be only one result of this. He did not underestimate the strength of the Bell system, and the fight was getting hotter. The Bell Company, he said, is in better shape to fight the independent companies than ever, but the independents are also in better shape to sustain attacks; all they had to do was to stand together. The stockholders in the 4000 independent companies by their political and social affiliations ought to be able in every way to dictate the telephone situation in the United States. He then proposed the following resolution, which was unanimously carried:

Be it resolved, by the Independent Telephone Association of the United States, in Convention assembled at Buffalo, N. Y., June 11, 12 and 13, 1901, That the thanks of this Association and of all persons whomsoever interested in the welfare of the independent telephone movement of the United States, is due to the officers of this association for their faithful, intelligent and untiring efforts to promote the welfare of independent telephony; and,

Be it further resolved, that thanks are especially due to Hon. R. S. Taylor, E. P. Payson, and others enthusiastically associated for the work done in the litigation recently decided by Judge Brown in the United States District Court for the Northern District of Massachusetts, involving the validity of the so-called Berliner patent, and that the successful conduct of this litigation is fully appreciated by this convention.

Be it further resolved, that the secretary be and is hereby instructed to prepare and forward to the persons herein named copies of this resolution.

Mr. C. T. Bash, Home Telephone Company, of Fort Wayne, Ind., in commenting on Mr. Critchfield's address, said that they now had 2146 independent subscribers there, although for 2½ years past every quarter the Bell Company had been sending receipted bills to the 500 subscribers, or less, on their system, who paid not a cent. As to needed legislation, he instanced a case in Fort Wayne recently, where, when the Wayne Hotel was on fire, the telephone line in an adjoining building was found to have been cut and thus warning could not be sent promptly through the exchange. There should be legislation to protect their circuits just as much as there was to insure the railroads against malice.

Invitations to hold the next meeting at Milwaukee, Philadelphia, Rochester, Mansfield, Ohio; Louisville, etc., were referred to the advisory board.

A committee of three, being appointed by Mr. Young, in the chair, to select a ticket for the ensuing year, the following ticket was reported and adopted very enthusiastically: President, J. M. Thomas, of Chillicothe, Ohio; first vice-president, H. C. Young, of Columbia, Pa.; second vice-president, C. E. Stinson, Rochester, N. Y.; third vice-president, W. H. Durin, of Cedar Rapids, Iowa; secretary and treasurer, S. P. Sheerin, of Indianapolis; first assistant secretary, J. B. Wart, of Detroit; second assistant secretary, C. E. Wilson, Philadelphia; third assistant secretary, J. B. Lee, of Pittsburg, Pa.

After the disposal of some routine matters the convention adjourned *sine die*.

Abstracts from Foreign Contemporaries

Sparkless Disconnection of Shunt Motors.—In a recent issue of the "Electrotechnische Zeitschrift," Rudolph Krause discusses the conditions under which sparkless disconnection of shunt motors occur. A method with which everyone is familiar is to simply open the main switch while the motor is running at full speed. The inductive discharge of the field magnet winding is eliminated by reason of its being connected to the armature circuit. The field circuit is therefore not opened at all and the counter e.m.f. of the revolving armature tends to maintain the field excitation, the armature acting as a generator on account of its kinetic energy. In the Fischer-Hinnen arrangement shown by Fig. 1 it will be seen that the starting resistance is connected between the armature and field; at normal speed the lever of the switch is at the point *s*, so that the starting resistance is in series with the field, but as its resistance is but 5 per cent of the resistance of the field winding, an increase in the speed of the motor of much less than 5 per cent results, and this is almost negligible. The arrangement shown by Fig. 2 has been proposed by C. L. R. E. Menges. This, while not so good as the arrangement shown in Fig. 1 for large motors, gives sparkless disconnection for smaller motors.

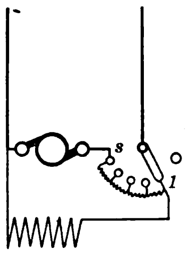


FIG. 1.

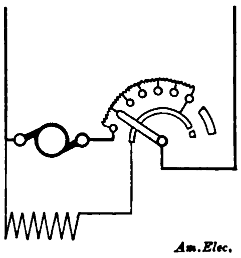


FIG. 2.

Ohmmeter for Workshop Use.—Kenelm Edgecumbe describes in a recent issue of the London "Electrician" an ohmmeter designed for the rapid comparison of low resistances on a commercial scale. Fig. 3 shows the connections in diagrammatic form; *B* is a source of direct current, not necessarily constant; *S* is the standard with which the unknown resistance, *R*, is to be compared and *C* and *D* are two coils rigidly fixed to the same axis, which is so pivoted as to allow the coils to rotate in a strong permanent magnetic field, as in ordinary moving coil instruments. The two coils are connected in such a way that they tend to turn in opposite directions, and the pole pieces of the magnet are so cut away that, as it moves round, one coil gets into a stronger and stronger field, while the other gets into a weaker and weaker field. The result is, that for any given ratio between the voltage drop in *R* and *S*, the moving system takes up a definite position, which is quite independent of the current flowing, and which is indicated by a pointer carried by the coils and moving over a graduated scale. The reading is independent of the value of the current, except that if the drop be reduced below a certain limit, the flexible connections introduce a slight uncertainty. Besides being perfectly dead-beat and direct-reading, the instrument has the ad-

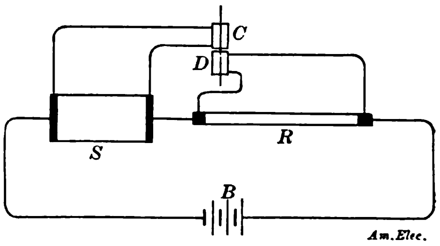


FIG. 3.—DIAGRAM OF CONNECTIONS.

vantage of enabling a resistance to be measured at its normal working current, and without removal from the circuit in which it may be connected. Thus, for example, the resistance of the coils between neighboring commutator bars can be readily compared without disconnecting them from the lugs, and a fault immediately localized. The author does not claim for the instrument the same accuracy that can be obtained by the potentiometer method; but the latter requires a constant current, whereas the former method utilizes any available source of current. The two coils being in the same case, temperature errors are eliminated.

Nernst Lamp Heater.—A recent issue of the "Zeitschrift für Beleuchtungswesen" contains an illustrated description of devices of Raab for automatically lighting a Nernst lamp. As will be seen by Fig. 4, the arrangement is based upon the principle of the Wheatstone bridge. The glowers of the lamp are represented by *a* and *b*; *c* and *d* are resistances of suitable value, and *f* is the heating conductor. When the lamp is switched on, as is well known, the glow-rods being cold do not conduct and the current flows through *c*, *f* and *d*. The heating device, *f*, then heats the filaments *a* and *b* to a temperature where they become conductors, whereupon the current flows partly through *c* and *d* and partly through *a* and *b*, until finally no current at all, or very little, flows through the heating device, *f*, accordingly to the principle of the Wheatstone bridge. The glowers, *a* and *b*, are then, of course, incandescent.

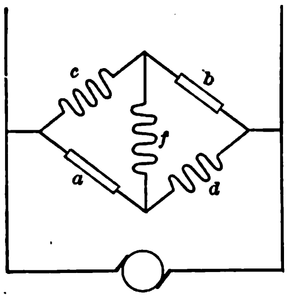


FIG 4.—NERST LAMP PREHEATER.

Commelin-Viau Gas Battery.—Two gas battery cells made according to patents of Commelin and Viau and having certain peculiar features are described in a recent issue of the London "Electrician." One is a gas accumulator based on the employment at the positive pole of oxygen and of a cadmium deposit at the negative pole. In the laboratory apparatus, shown diagrammatically in Fig. 5, the anode consists of a hollow carbon cylinder, *C*, communicating by a tube, *S*, with the reservoir, *R*, this latter being connected to the outer cell, *V*, by a second tube with a tap, *T*. The cathode is a cylinder of antimonious lead, *P*, surrounding the carbon, *C*, and the electrolyte is a solution of cadmium sulphate.

The apparatus is hermetically sealed, and the charging current produces a deposit of cadmium on the negative, *P*, while oxygen is evolved at the carbon, *C*. This oxygen accumulates in the upper part of the cell, *V*, and passes through the tube, *T*, into the reservoir, *R*, whence it is diffused by the tube, *S*, into the interior of the carbon, *C*. When the pressure-gauge, *M*, indicates 1 kg. pressure the cell is ready to furnish a discharge current. The tap, *T*, is closed, and on connecting the two poles through the circuit the pressure, which was equal in the cell *V*, the reservoir *R*, and the carbon *C*, begins to diminish in the cell *V*, in consequence of the decomposition of the water by the cadmium, which is converted again into cadmium sulphate. The nascent hydrogen at the positive pole, *C*, combines with the oxygen in the pores of the carbon and forms water. As the oxygen in *C* is under pressure, and the pressure in the outer cell, *V*, continually diminishes, the oxygen is continuously passing outward through the pores of the carbon. The electromotive force of the battery is 1.5 volts, and the current is stated to be 0.25 to 0.30 ampere per square decimeter of cathode surface. In the form of battery shown by Fig. 6, which is intended for actual industrial use, the hollow carbon cylinder is replaced by rows of small porous carbon tubes packed one against the other so as to form a plate, and these tubes terminate in a common chamber. The chambers of all the cells of a battery are in communication, and similarly the gases of all the cells *V* are in communication, so that one tap, *T*, suffices for all. The cathode is formed of celluloid troughs placed one above the other, along the bottom of each of which is a strip of lead, the ends of these strips being connected together by autogenous solder to form the negative plate. The cadmium deposits itself on these lead strips.

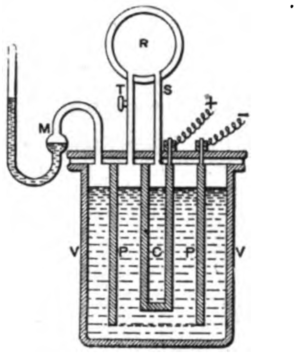


FIG. 5.—LABORATORY FORM OF COMMELIN-VIAU GAS BATTERY.

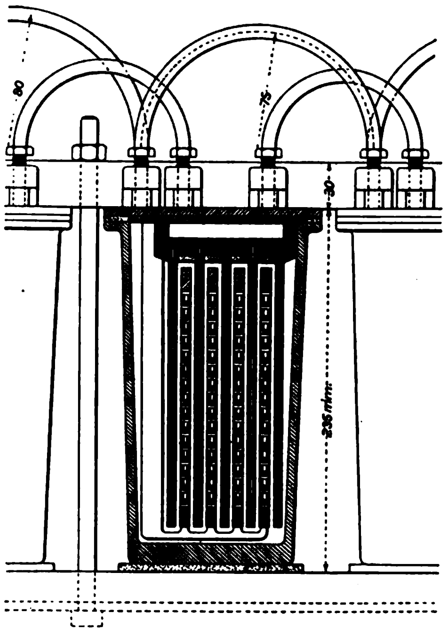


FIG. 6.—COMMERCIAL FORM OF COMMELIN-VIAU GAS BATTERY.

The second cell likewise makes use of cadmium. The anode is made up of an ebonite grid, Fig. 7, on which is riveted a conducting frame of lead of the form shown in Fig. 8, and the interstices of the grid are filled up with lead peroxide paste. The negative plate, Fig. 9, is a sheet of insulating material, on the two sides of which are thin sheets of lead 0.2 mm. thick, carrying sloping celluloid shelves 8 mm. apart, as shown; the object of these being to support the cadmium deposited from a solution of sulphate of cadmium with which the cell is filled. Against these shelves is a perforated sheet of celluloid, so that the peroxide plate can be fixed flat against it. On charging, peroxide of lead is formed at the positive and cadmium on the negative, sulphuric acid being set free in the liquid. On discharging, the peroxide is reduced, the cadmium is attacked by the sulphuric acid, and the solution returns to its former state. When completely discharged it is claimed that there is no sulphating of the positive plate, as no sulphuric acid is left in the solution. The e.m.f. of this cell is from 2.15 to 2.20 volts, and it is claimed that the capacity is as great as 30 ampere-hours per kilogram of plate. This, it is said, may be increased to 40 ampere-hours when a carbon plate 2 mm. thick replaces the lead sheets and celluloid partition of the negative plate.

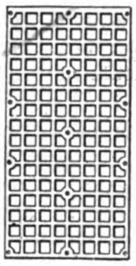


FIG. 7.

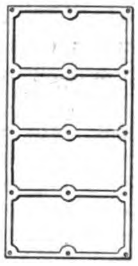


FIG. 8.

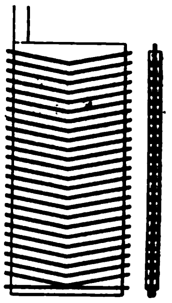


FIG. 9.

Insulation Resistance of Wiremen's Gloves.—A recent number of the "Bulletin de la Société Internationale des Electriciens" contains a paper read by Janet before the Société in Paris, in which the author gives an account of laboratory experiments performed by him in order to find the insulation resistance of different types of gloves for wiremen. The experiments were performed first with the gloves dry and then with them wet, the pressure being 105 volts in each case. In the dry test the gloves were filled with mercury and then suspended in a basin of mercury. In the wet tests instead of mercury, fine sand moistened with acidulated water was used. The resistance in megohms ranged from zero to 52,500 dry and from zero to 420 wet. The author also made wet tests for determining the effective e.m.f. at which the gloves broke down under high-pressure alternating currents. Three of the samples broke down at low voltage, while three others broke down at 1000, 2000 and 11,000 volts respectively. In the discussion which followed the reading of the paper it was argued that insulating gloves cannot generally be regarded as an effective protection; and that wiremen with gloves should not touch the conductors directly, but only such parts as are already insulated.

Small Direct-Current Meter.—The London "Electrician" has in a recent issue a description of a new small meter for direct currents brought out by the Allgemeine Elektricitäts Gesellschaft of Berlin. The meter is made up of two parts, as shown by Figs. 11, 12 and 13. One part, illustrated by Fig. 12, consists of a fixed coil, *H*, through which the main current passes, and a moving shunt coil, *S*, on a spindle, *A*. On this spindle are also fixed the braking disc and a contact arm, *K*, which at two positions makes electrical connection with contacts K_1, K_2, respectively. Two fixed resistances, W_1, W_2, are also alternately in parallel with the shunt coil, as shown diagrammatically in Fig. 11. The other part of the apparatus is a relay which actuates the clockwork, and is made up of an armature pendulum, *R*, which is alternately attracted to the electromagnets, E_1, E_2, thereby making connection with contacts, C_1, C_2, respectively. The action of the meter may be traced from the diagram, Fig. 11. In the position shown, the coil, *S*, and resistance, W_2, are in parallel, and the direction of the current is such that the contact arm, *K*, is moved to K_2. This short-circuits the electromagnet, E_2, and the pendulum is attracted to the magnet, E_1, and makes contact with C_1. The coil, *S*, is now in parallel with the resistance, W_1; the current, however, being reversed, the coil moves in the opposite direction, so that the arm, *K*, makes contact at K_1, and the magnet, E_1, is short-circuited, and so on. The instrument is made for currents up to 10 amperes, and pressures up to 500 volts. The meter is guaranteed not to run on no-load, even with a pressure 20 per cent above the normal; and to start with 1 per cent of the maximum current. It is also claimed that but 1.2 watts are lost in the shunt for the 100-volt meters and 8 watts in the main coil.

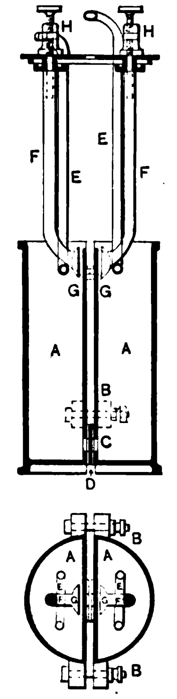


FIG. 10.

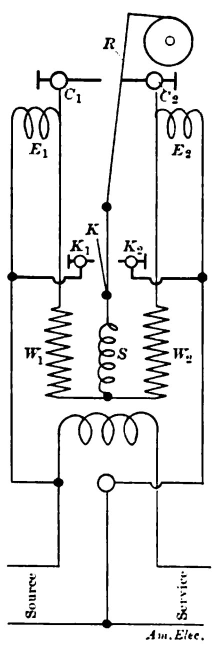


FIG. 11.

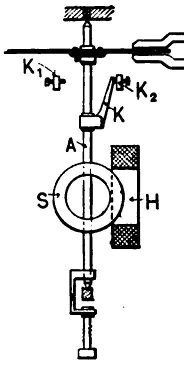


FIG. 12

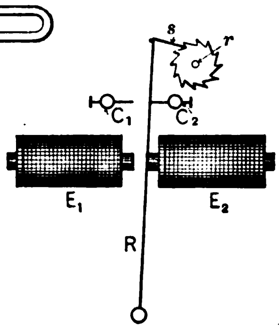


FIG. 13.

Improved Simon Interrupter.—Ernest Ruhmer, writing to the "Elektrotechnische Zeitschrift," describes an improved Simon interrupter, where in order to obviate the disadvantages attending the wearing out of the perforated wall in the interrupter he uses the arrangement shown by Fig. 10. The apparatus is divided into two semi-cylindrical porcelain vessels, *A A*, joined by means of bolts, *B*, and communicating through a narrow channel, *C*, which is further narrowed by the introduction of a thin porcelain plate, *D*, having through its center one or more countersunk holes. The electrodes, *F*, *F*, are of lead, having the terminals, *G*, *G*, widened so as to nearly cover the channel, *C*, when lowered to the proper position. Water circulates through *E*, *E*, and serves to keep the apparatus cool. The electrodes are well protected just beneath the cover from the sulphuric acid spray so as to guard against short-circuits.

Alternating Current Measurements.—Recent issues of the London "Electrical Review" contain an article by A. Campbell on test-room methods of measuring alternating currents. A well-known method of measuring alternating current is to send the whole current to be measured through the primary of a transformer, whose secondary is connected to an ammeter. This method requires, however, an air-core transformer, or one having a well-closed iron circuit, also relatively low resistance and high inductance in the secondary circuit. Another method shown by Fig. 14 is to pass the current through a low non-inductive resistance, *R*, giving a small voltage drop which is transformed up so as to give readings on the electrostatic voltmeter, *E*. The instrument being electrostatic is not affected by variations in frequency. For currents of 5 amperes and upward, the resistance, *R*, should be of such a magnitude that not more than 0.5 or at most 1 volt will be lost in it. If the voltmeter reads to about 120 volts, a high transformation ratio, at least 1 : 100, is required. The author finds that with a transformer having a well-closed iron circuit and a highly inductive primary of low resistance the voltmeter readings are proportional to the current. He compensates for changes of frequency by a modification shown by Fig. 15. Here the total current, after passing through the small resistane, *R*, passes over a turn or two on a very small compensating transformer, *t*, whose secondary is connected, reversed, in series with the secondary of the main transformer, *T*, and the voltmeter. As the frequency is raised, the transformer, *t*, subtracts more and more from the voltmeter reading, and thus compensation is secured.

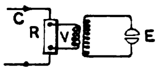


FIG. 14.

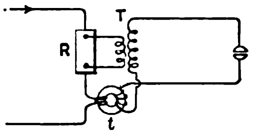


FIG. 15.

Among numerous methods of measuring power the author describes the following modification of the three voltmeter method which obviates the use of the auxiliary resistance heretofore used in order to obtain good readings, and which often used up a considerable fraction of the total available voltage and altered the wave forms in the circuit. In Fig. 16 *r* is a relatively small resistance, and *R* a very high resistance in parallel with the load, *W*. A tap is led out from the resistance, *R*, and the usual three-voltmeter method is applied to *A*, *B*, *D*. The result multiplied by the reciprocal of the fractional part of the resistance that is tapped off gives the power taken by *W*. An interesting zero method of measuring direct current is shown by Fig. 17. The whole or part of the current passes through the small wire, *A*, and also through a strip or rod of very low resistance, *B*. The heating of *A* by the current causes the thermopile, *Th*, to give an e.m.f. which is balanced against a part of the voltage drop along *B* by moving the slider, *D*, until the galvanometer deflection is zero. The graduations of the scale on the slider are directly proportional to the current measured. The author also describes a method of obtaining steady currents with varying supply voltage. He accomplishes this by means of a Wheatstone bridge arrangement with two different metals for wires having large and small temperature coefficients respectively, the metals in this case being nickel and manganin.

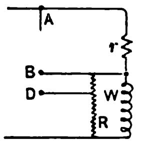


FIG. 16.

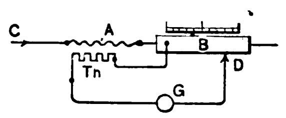


FIG. 17.

Some Recent Electrical Patents

Rail Bond.—In order to provide a rail-bond which shall be entirely flexible and at the same time continuous and integral between the two points where it is connected to the abutting rails, W. T. Pringle has devised the form of bond shown by the accompanying illustration, Fig. 1. The bond consists of a slotted strip, *A*, of conducting material, having at each end rivet tubes formed integral with the strip about metallic plugs, *D*. The rivet tubes, *B*, are inserted in holes in the rails, and when the ends are headed over in the ordinary manner, the plugs, *D*, serve to make the contact between the rivet shell, *B*, and the rail more intimate than would otherwise be the case. Patent No. 673,660.

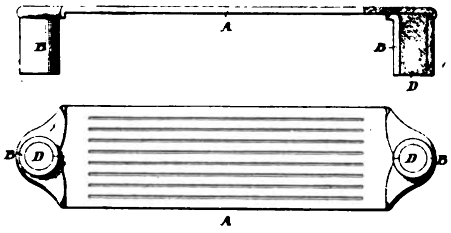


FIG. 1.—FLEXIBLE RAIL BOND.

Incandescent Lamp Socket Shell.—The perversity of inanimate objects is never better demonstrated than in the case of the average lamp socket shell, which, as most persons having anything to do with them know, manifests a peculiar tendency to come apart where the shell enters the base, at the most inopportune times. With a view to preventing this disarrangement, W. H. Perkins proposes to use the form of bayonet lock shown by Fig. 2. At first sight the bayonet lock does not seem to differ materially from the ordinary one, but close inspection will show that the bayonet slot in the base of the socket terminates in a circular contour instead of an ordinary rectangular slot, and that the retaining screw shown at the bottom of the engraving on the left is provided with a shoulder, 5, which enters the circular part of the bayonet slot and prevents the shell of the socket from being twisted in the base after the screw has been set up. The patent also provides for locating the bayonet slot in the shell of the socket and the circular hole in the base, the reverse of the arrangement here shown. Patent No. 676,202.

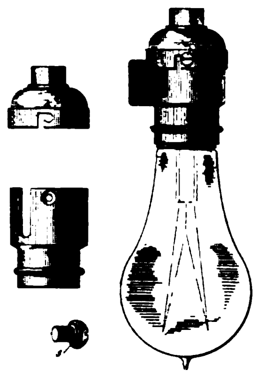


FIG. 2.—BAYONET LOCK FOR INCANDESCENT LAMP SOCKET SHELL.

Method of Railway Motor Control.—With a view to eliminating some of the disadvantages which characterize the series-multiple method of railway motor control, E. C. Parham has devised a method which is roughly illustrated by the diagram, Fig. 3. The principal disadvantage which the invention is designed to eliminate is that of the mechanical and electrical shock which is dealt to the motors when the controller changes from series to parallel. The invention, as described in Mr. Parham's patent, consists of connecting the motor armatures permanently in parallel with each other, and connecting the field magnet windings of both motors permanently in series with each other and with the paralleled armatures, starting the motors with an adjustable resistance in series with the entire group. Acceleration is accomplished by cutting out more and more of the external resistance, and when this is finally all cut out of circuit the field magnet windings of the two motors are shunted, as indicated at the bottom of the diagram. Patent No. 674,981.

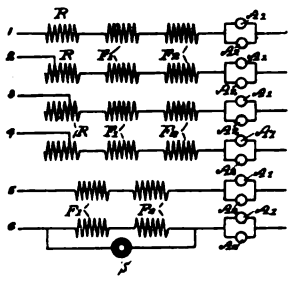


FIG. 3.—DIAGRAM OF CIRCUITS; RAILWAY MOTOR CONTROL.

Safety System for Rotary Converters.—When rotary converters are operated in parallel it is sometimes found desirable, particularly when the field winding is compound, to considerably weaken the field magnet excitation in order to cause the alternating supply current to lag behind its e.m.f. at no load, and change to a leading current under heavy loads under the influence of the action of the series field magnet winding. In other cases the series field magnet winding may be stronger than is desired, and the shunt excitation will therefore be weakened to give the desired combined excitation. Under either of these conditions, if the alternating-current supply circuit should be opened, the series field would be immediately reversed by a flow of current from the direct-current systems to the rotary converter armature, and the machine would operate as a direct-current motor under the magnetizing effect of its shunt winding, and would be likely to speed up under the demagnetizing effect of its series winding. In order to obviate such a condition B. G. Lamme has patented the arrangement shown in the accompanying diagram, which consists merely in introducing a circuit-breaker in the armature circuit with the release magnet connected in series with the shunt field winding and arranged so that when the current in the shunt field circuit *falls below* a predetermined amount the magnet will release the circuit-breaker and open the armature circuit on the direct-current side. The current at which the circuit-breaker is set to operate is obviously the one which provides so small a degree of field magnet excitation that when it is opposed by the demagnetizing effect of the series winding with the no-load armature current (considering the machine as a direct-current motor) passing backward through that winding it will not hold the speed of the armature down to a safe rate. The arrangement is intended for a safeguard only in the event of the failure of the alternating-current supply, of course. Patent No. 673,913.

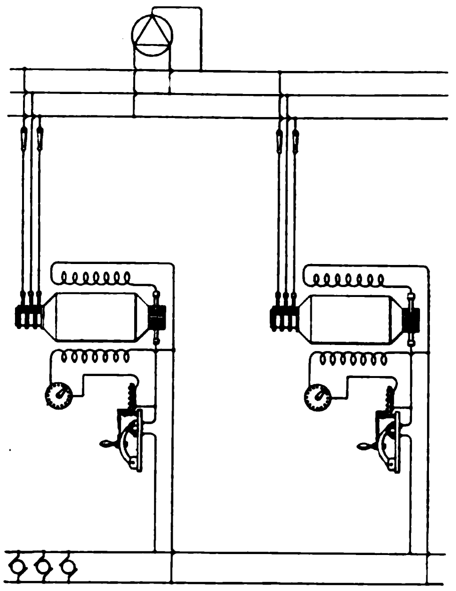


FIG. 4.—SAFETY SYSTEM FOR ROTARY CONVERTERS.

Starting Winding for Electric Motors.—Fig. 5 herewith illustrates diagrammatically a winding and its connections which have been patented by Arthur P. Warner with a view to simplifying the control of motors which are required to start frequently under load, such as motors for elevator service. The arrangement consists in providing an ordinary shunt winding, *B*, which furnishes constant excitation, and an auxiliary series winding, *E*, which, although in series with the armature, as usual, has unusual connections. The starting resistance, shown at the bottom of the diagram, is connected in shunt relation to the series winding, *E*; consequently, at the moment of starting almost the entire armature current passes through the series winding, *E*, the starting resistance at this instant being relatively high. As the starting resistance is cut out, however, it shunts more and more of the current from the series winding, as well as reducing the resistance of the armature circuit, and when all of the resistance is cut out the series winding is obviously short-circuited, so that the machine operates as a plain shunt motor. Patent No. 676,520.

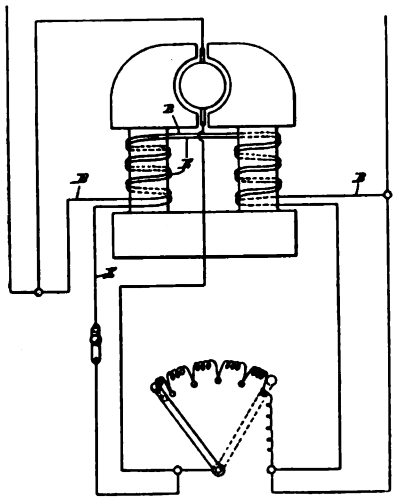


FIG. 5.—STARTING CONNECTIONS FOR MOTORS.

◆

Photometer Sight Boxes.

To the Editor, American Electrician;

Sir:—The article of Prof. Stine on "The Choice of a Photometer for Central Stations" in the June number of the American Electrician should be of much practical benefit to an inexperienced operator. I would like to supplement this excellent article with some points as to sight boxes.

Given a bar and lamp supports to meet the individual requirements, the question of the screen best adapted to the particular purpose, is of the greatest importance. It might be said in a general way that there is as much difference existing between Lummer-Brodhun sight boxes of different makes as there is between Lummer-Brodhun sight boxes and Bunsen sight boxes. That is, there are forms of Bunsen sight boxes which give much more concordant readings than those obtainable with certain Lummer-Brodhun boxes under identical conditions. Lummer-Brodhun boxes can be made so that an experienced operator can obtain successive readings which do not differ from each other by more than 2 millimeters on a 2500 mm. bar, and which give reversed readings within 2 millimeters.

There are Lummer-Brodhun boxes, however, and in this class may be included some of those imported from Germany, with which it is impossible to obtain successive readings which agree within 6 or 8 millimeters, and which have a difference on reversal of 15 millimeters. In fact, one Lummer-Brodhun box which came under my observation and which was furnished with a high-grade outfit had a reversal difference of between 35 and 40 millimeters. It is needless to add that such differences are too great to allow the average of a number of readings to represent an accurate mean and true setting. Almost the same statements will apply to the Bunsen screen. Accurate settings can only be made with a sensitive screen and while it is a comparatively simple matter to make a star-shaped grease spot calling it with its mounting a Bunsen sight box, it is a very difficult operation to make this spot a sensitive and efficient one.

A series of nine double readings made by an experienced operator on a 5200-mm. bar with a well-constructed Bunsen spot showed a maximum variation of 7 millimeters from the mean, and a reversal difference of 11 millimeters, which result, although poor, is a very fair average of the usual sight boxes furnished and compares favorably with the readings obtained from badly constructed Lummer-Brodhun carriages.

There is on the market at the present time, however, a form of Bunsen screen* which has an exceedingly high sensibility and small reversal difference. It is made in such a way that the edges are absolutely sharp and the coating of wax perfectly uniform. A series of nine double readings taken by an inexperienced operator on a 2500-mm. bar showed a maximum variation of 2½ millimeters from the mean and a reversal difference of 2 millimeters. In another test, an operator with several years' experience in photometric work obtained under conditions similar to above a variation of two millimeters from the mean of nine readings and a reversal difference of two millimeters. This result shows that the screen is an especially good one for inexperienced operators, that it is constructed on correct principles, and that the results obtainable with it are almost equal to those obtainable with the best Lummer-Brodhun screen.

Another point to be considered is the speed of measurement. With the new form of Bunsen screen just mentioned, the time occupied in making the 18 settings was nine minutes. The time for making the same number of settings with a Lummer-Brodhun carriage was 18 minutes, or exactly twice as long. Then, the highest sensibility with the Lummer-Brodhun screen is obtained only when the room is very dark and the eyes of the operator thoroughly protected from the light. With the Bunsen screen this is not so necessary, as settings can be made with sufficient light in the room to make the readings of the pointer clearly visible, without interfering with the accuracy of settings.

It would seem, therefore, from actual experience that such a screen properly made is a rival to the Lummer-Brodhun and for comparatively inexperienced operators offers many advantages.

Wm. B. Hodge.

Oak Lane, Pa., June 5, 1901.

NEW BOOKS.

Saw Filing. By Robert Grimshaw. New York: Norman W. Henley & Co. Boards; 93 pages, 4 x 6 ins.; 81 illustrations. Price, $1.

This is an excellent little book so far as it is intelligible. Mr. Grimshaw's advice and instructions are sound and if his skill in conveying knowledge were commensurate with his evident skill in handling saws the book would be almost without flaw. The author discusses all sorts of saws, and his instructions for hammering circular saws are particularly sensible, but it is a pity that they are not more clearly expressed.

Instructions for the Use of Telephones Furnished by the United States Signal Corps. By Capt. Samuel Reber, U. S. A. Published by the United States Government. Boards; 54 pages, 4½ x 7 ins.; 49 illustrations. Supplied by the Government Printing Office, Washington, at cost.

Although issued solely as a guide for members of the U. S. Signal Corps, this little book will be found of great value to students and others in civil life who are interested in telephonic work, but lack knowledge of the construction of instruments and arrangement of circuits. The instruments of most of the representative manufacturers are described and illustrated, not in catalogue style, but with discriminating intelligence and a clarity of exposition that are positively refreshing. The instructions for locating faults might have been profitably elaborated to several times the space occupied by this part of the book, and the use of lithographed illustrations printed on "plates" at the back of the book is not commendable. But this, we believe, is the "style" generally observed in government publications.

NOTES.

Parlor Cars on a Trolley Line.—The Brooklyn Rapid Transit Company agreeably surprised its patrons recently by introducing through parlor-car service between New York and Brighton Beach, on the south shore of Long Island. The cars are very roomy and equipped with comfortable arm chairs and lounging seats. A single trip fare of 25 cents was charged and the cars were well patronized as soon as the service was put into operation.

International Association of Municipal Electricians.—The sixth annual convention of this association will be held in the Natural Food Company's convention hall on September 2, 3 and 4. Messrs. W. G. Gree, 473 Second Street, and M. J. Donohue, Superintendent of Fire Alarm Telegraph, Niagara Falls, will secure accommodations in advance at any of the hotels for anyone who desires them. A list of the hotels and their rates may be obtained from Frank P. Foster, secretary of the association, whose address is Corning, N. Y.

---

*Made by Queen & Co.

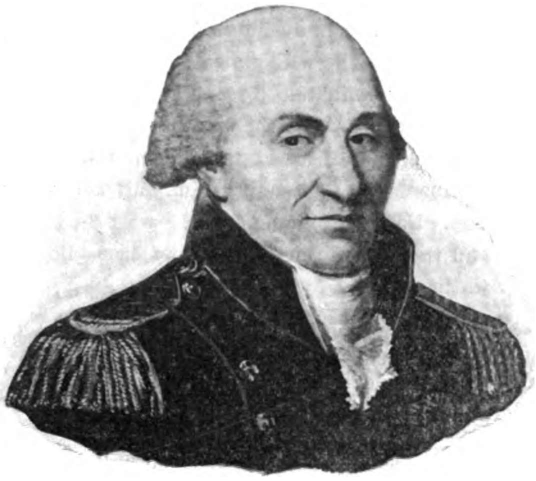
The Ohio Electric Light Association.—The next annual meeting of this association will be held on August 20, 21 and 22 at Hotel Victory, Put-in-Bay, on the shore of Lake Erie.

Expensive Junk. — The Metropolitan Street Railway Company, having equipped its old cable lines with electric power, is considering the cheerful prospect of breaking up and selling as old junk $1,600,000 worth of cable machinery, which is practically as good as new but which has become entirely valueless now that the cable equipments have been displaced by electrical apparatus. The largest plant is in the Houston Street building; this was put in in 1893 at a cost of nearly $1,000,000.

A Freight and Passenger Electric Road.—The contract has been awarded for the construction of the Augusta & Aiken Railway, which will run from Augusta, Ga., through Bath, Warrenville, Langley, Graniteville, to Aiken, a distance of 20 miles; the road has also secured valuable franchises in the city of Augusta. This company will be owned by the North Augusta Electric & Improvement Company, which latter company also owns the North Augusta Land Company, North Augusta Development Company and North Augusta Railway Company. The board of directors is composed of James U. Jackson, J. William Middendorf, R. Lancaster Williams, John Blair MacAfee, Ernest Groesbeck, Alfred S. Elliott, Henry Buist, Walter M. Jackson and Martin Verdry. The road will be built on private right of way and will be of standard steam railroad construction, being intended to carry both passengers and freight. Its equipment will include two electric locomotives for freight service. The contract for the complete construction and installation of the road, power plant and equipment has been awarded to John Blair MacAfee, of Philadelphia. Mr. Walter N. Walmsley will be chief engineer and will be assisted by Mr. G. Edwin Heath and Mr. William Harrison MacAfee, civil engineers.

Splendid Gifts to the American Institute of Electrical Engineers.—Dr. Schuyler S. Wheeler has donated to the American Institute of Electrical Engineers the entire library of the late Latimer Clark, who, it is well known, was one of the founders of the British Society of Telegraph Engineers and one of the most prominent English physicists. But for Dr. Wheeler's promptness in negotiating for the library upon learning that it had been offered for sale, it is likely that it would have passed into the hands of some other country, probably either Germany or Japan, whose agents had been in correspondence with the executors of the Latimer Clark estate for some time. When it was first known that the Latimer Clark library could be bought, Mr. Andrew Carnegie had considered purchasing it for the Institute, and upon being informed that Dr. Wheeler. becoming uneasy lest the library should pass into other hands, had stepped in and purchased it himself, Mr. Carnegie generously donated a sum equal to that paid by Dr. Wheeler for the library, to be used in properly housing and cataloguing the Latimer Clark collection. The cost of the library was $6880, and Mr. Carnegie's donation is therefore this sum.

Coulomb.—In the series of articles entitled "A Biographical History of Electricity," which appeared in these pages during the years 1896-98, portraits were presented of all the great pioneers in electrical science from Gilbert to Faraday, with the single exception of Coulomb. In the article treating of Coulomb and his work it was stated that numerous inquiries and an extended search in libraries had brought to light no source from which a portrait could be obtained, but that steps had been taken to have a photograph taken of a bust in Paris, from which an engraving would be made and printed in a future issue. It was subsequently learned that the information as to the existence of a bust of Coulomb in Paris was incorrect, and the search for the portrait copy was continued. Among those who lent aid in this search was a distinguished member of the French Academie des Sciences, which body Coulomb had adorned, who instituted an investigation in the archives of the Academie and the engravings department of the Bibliotheque Nationale, but with no result, and it was finally concluded that no portrait of the founder of electrical measurement was in existence. Quite recently, however, in turning over a collection of old pamphlets the surprising discovery was made that one of these, written by Prof. Edwin J. Houston, contained an excellent portrait of the French savant. Upon communicating with the author, it was learned that the portrait was engraved from an oil painting in the possession of a great-grandson of Coulomb residing in Philadelphia, where he is the principal of a city school. Through the courtesy of Prof. Houston a photograph of the painting was obtained, and from this the accompanying engraving was made.



CHARLES AUGUSTIN DE COULOMB.

A Pathetic Case.—The following letter appeared in the New York Sun:

> To the Editor of the Sun:
>
> Sir:—The Pan-American Exposition at Buffalo is using so much electricity generated by the power from Niagara Falls that it seriously affects the atmosphere, weather and climate within a radius of more than 500 miles, causing fearful storms, laying waste towns and villages, sweeping like the besom of destruction, over whole counties. They are proud of their splendid display of electric light, but don't consider that it is the cause of these disasters. Scientists know it. It must be stopped. Revoke the charters; take the cables out of the heavens; stop the dynamos or take the consequences. Every revolution of a dynamo tends to upset the whole oxygen of the air. Science.
>
> New York, June 10.

If the persons who merely seek aggrandizement and affluence from electrical development have no more sense of the aesthetic than to hang their cables up in the heavens there is no way to prevent it, but the law should be invoked against the conscienceless mercenaries who upset our oxygen.

Steam Engine Specifications.—The Engine Builders' Association of the United States at its recent meeting held at Indianapolis, prepared the following suggestions relating to specifications for the installation of steam engines, these suggestions being made for the consideration of architects and engineers who draw specifications for such plans:

(1). That contracts which provide a penalty to deliver in time or for failure to meet guarantees ought also to provide equal premiums for earlier delivery or better draw specifications for such plans:

(2). That bonds should not be required on installation contracts unless corresponding bonds for similar amounts are given to secure payment. An exception always being made in the case of Government, State or municipal contracts.

(3). That settlements or any part of them not to extend beyond three months from completion of contract, and that delay on the part of the owner ought not to delay payment beyond a reasonable time.

(4). That a guarantee against defective material or workmanship should not be made to cover a period of more than one year from date of shipment.

(5). That purchasers of engines ought not to be furnished with complete working drawings, but simply with general drawings showing the assembled engine in outline, with such principal dimensions as will answer for building foundations, the erection of engines or their care.

The fifth provision will doubtless appear arbitrary and unjustifiable to engine users. It would seem that anyone who buys any piece of machinery has a right to the most complete information concerning its construction.

ESTABLISHED 1889.

American Electrician,

WITH WHICH IS INCORPORATED

Electrical Industries.

CECIL P. POOLE, Editor.
W. H. ONKEN, Jr., Associate Editor.

Published on the first of each month by the

American Electrician Company,

NEW YORK: 120 Liberty Street.
CHICAGO: Monadnock Block.
PHILADELPHIA: 929 Chestnut Street

JAMES H. MCGRAW, President.
A. E. CLIFFORD, Vice-President.
C. E. WHITTLESEY, Treasurer.
E. E. WOOD, Secretary.

Subscription, - $1.00 Per Year.
In the United States, Canada and Mexico.
FOREIGN COUNTRIES, $2.00.

NOTICE TO ADVERTISERS.

Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

IMPORTANT NOTICE.

Intending subscribers are warned not to place subscription orders with persons who cannot show written authority to take such subscriptions and make collections therefor, as the paper will not undertake to fill orders placed with alleged agents acting without such written authority.

Subscribers requesting a change of address should invariably furnish both the old and the new address.

Vol. XIII. JULY, 1901. No. 7

The American Electrician has a larger paid subscription list than any other electrical journal in the world.

CONTENTS.

A Water-Power Railway Plant with Alternating-Current Transmission......... 321
Photometric Values of Arc Lamps, by C. P. Matthews........ 324
Arc Lighting at the Beginning of the Twentieth Century, by W. H. Hillman 326
The Central Station Boiler Room, by William D. Ennis, M. E.......... 327
Niagara Convention of the National Electric Light Association.......... 330
Construction, Calibration and Care of Steam Gauges, by C. W. Obert......... 337
The Selection of a Steam Engine, by William D. Ennis, M. E.......... 338
Simple Method of Obtaining Two Three-Phase Secondary Voltages.......... 339
Decorative Lighting at the Pan-American Exposition 340
The Independent Telephone Convention.. 344
Abstracts from Foreign Contemporaries 348
Some Recent Electrical Patents.......... 351
Photometer Sight Boxes, by Wm. B. Hodge 352
New Books 352
Notes 352
Editorial 354
Design for a 400-ampere Electroplating Dynamo, by Cecil P. Poole.......... 356
Starting Rotary Converters, by Arthur B. Weeks 358
Reading a Recording Wattmeter.......... 360
Common Battery Telephone Systems, by W. S. Henry.......... 361
Lessons in Practical Electricity.......... 362
Letters on Practical Subjects.......... 363
Electrical Catechism 364
Queries and Answers.......... 365
Comparative Testing of Fan Motors, by A. R. Everest.......... 366
Bisulphate of Mercury Primary Battery 366
Fan Motor Efficiency.......... 367
An Important Industrial Deal.......... 367
Twentieth Century Engine.......... 367
Some Exhibits at the Pan-American Exposition 368
New Apparatus and Appliances.......... 372
Electric Light Convention Notes.......... 375
Telephone Convention Notes.......... 376
Obituary ....Adv. 31
Personal ....Adv. 32
Trade Publications..........Adv. 32
Business News..........Adv. 32

The Pan-American Display.

To be convinced that the lighting effects at the Pan-American Exposition are remarkably fine one needs but to glance at the specimen night views reproduced on other pages of this number. All the descriptions that could be written, however, must prove inadequate to convey to one's mind a realizing sense of the scene, which is indescribably beautiful. And any description must also be futile from a technical point of view, so long as the Exposition authorities continue to maintain the testaceous degree of reticence that has thus far balked all efforts to obtain any engineering information worth the asking. So far from realizing that a contribution of some value to engineering data might be made by an accurate showing of the relation between the fine distribution of light attained and the number of lamps used, the officials of the engineering department decline to give out any figures because, forsooth, the public might be disappointed in the actual number of lamps! It is barely possible that this reticence is due to a desire to avoid discrediting the wild statements that have been disseminated by the publication bureau concerning the number of lamps used; one of these statements places the number at 300,000, another at half a million. Now, the lamps are 28.8-watt 8-c.p., and the transformer plant is of 4500 kilowatts capacity.

◆

Arc Lamp Performance.

That anyone in any degree familiar with electric lighting practice should still retain the remotest suspicion that a 2000-c.p. arc lamp ever did or ever will give 2000 actual candle-power is somewhat puzzling. Yet, when Prof. Matthews read his report before the recent electric light convention, several central station men of long experience expressed dissatisfaction at the actual candle-power given by the arc lamps which Prof. Matthews had tested, and one of those present even asked how it was that a "2000-c.p. arc" gave only the small candle-power shown by the tests! The reply, of course, was that there are no 2000-c.p. arc lamps (inferentially excepting projector lamps), and that lamps are rated by their normal wattage—we speak of 400-watt lamps, 500-watt lamps, etc. Were lamps of 2000 mean hemispherical candle-power used for street lighting, the community would soon be going about in either blue goggles or blinders.

As Prof. Matthews pointed out in some informal remarks, the term "candle-power" is somewhat misleading because the value of the British candle is difficult of precise determination. It is approximately equal to 0.88 of a Hefner unit, the latter being accurately determinable by means of the amyl acetate lamp—in proper hands and under proper conditions. Another objection to making candle-power or any other photometric unit the criterion of arc lamp performance is that it must be modified by one of two terms, "mean spherical" and "mean hemispherical"; and a third still greater objection is that it bears a very erratic and variable relation to the effective illumination of streets and plazas. This last objection applies with equal force to the use of wattage as a standard of rating, but this has at least the merit of being entirely intelligible to the average man as well as a perfectly simple basis of contract verification. If a town pays for service from 500-watt enclosed-arc lamps, for example, it is a trifling job to show whether or not the line current and lamp voltage meet the stipulation. What is needed industrially, however, is some equitable basis of comparing effective street illumination, entirely irrespective of lamp wattage and photometric performance.

◆

Arc Lighting Systems.

The most desirable of the several arc lighting systems for use under average conditions is another question of which no generally-accepted solution has thus far been offered. There seems to be small doubt that the open arc is doomed so far as ordinary illumination is concerned. This conceded, the case reduces primarily to a choice between direct-current and alternating-current enclosed arcs, both of which possess points of advantage over each other. And in the case of alternating-current lighting, one is confronted by three systems of regulation between which to decide. In the paper read at the recent electric light convention by Mr. Hillman, the author evinced a strong preference for the constant-current transformer system, in which preference we do not concur.

Referring to the system in which are employed constant-potential transformers with separate regulators for maintaining constant current, Mr. Hillman pointed out that supplying all of the arc lamps from one transformer is risky, while, on the other hand, the use of several smaller transformers gives a more complicated system; these propositions are axiomatic. But he then made the remarkable deduction that because of these features of the constant-potential system, the constant-current transformer system is superior—which is far from obvious. It is not clear why a single large constant-current transformer can be considered more reliable than a single large constant-potential transformer, or why several smaller transformers of the "tub" type should be deemed less complicated than the same number of ordinary transformers with separate regulators. Our own opinion is that the exact reverse is true. Moreover, any damage to a separate regulator may be more easily rectified than a similar damage to a constant-current transformer, and reserve regulators can be carried in stock at less expense than can reserve transformers. Ignoring efficiencies and the excessive heating of constant-current transformer cores at light loads, all of the indications are strongly in favor of constant-potential transformers used in connection with some external means for preventing undue variations in the current of the arc-lamp circuits.

◆

The Conventions.

Although sharing Mrs. Partington's opinion concerning comparisons, we are impelled to point out what was noticed by everyone who attended both of the recent conventions, namely, the difference between the attendance upon the sessions of the two Associations. Notwithstanding the seductive proximity of the Pan-American Exposition, the attendance at the telephone convention at Buffalo was about three times as large as that at the electric light convention at Niagara, although the number of delegates registered was about the same in both cases. It may be that the comparative youth of the telephone industry constitutes a partial explanation for the greater manifestation of interest, there being a greater variety of "unthreshed" subjects; it is certainly true that the brethren of the transmitter do exchange experiences and opinions in convention much more freely than those who have to do with heavier currents and apparatus, but, again, this may be due to the talkative character of the telephone man's daily avocation.

It has been suggested that the difference is due to the more technical character of the papers read at the electric light conventions, rendering it difficult to discuss them at once. In perfect amity to all concerned, we incline to the belief that the relatively small number of valuable practical papers presented during recent years is more likely the solution of the small attendance and lukewarm attitude of the central station men now. A man can't discuss with a hilarious degree of enthusiasm a paper which has given him no information or raised no issues concerning the practical side of his everyday work. Statistical papers, to cite a single example, are not conducive to intent interest or animated discussion, except when they serve to show definite advantages derived from some change in plant or policy, full particulars of which are given.

It is by no means intended to intimate that no good papers are read at the electric light conventions. On the contrary, there have been many such, and we take pleasure in pointing out that at the convention just held a considerable proportion of the papers read were of the class calculated to attract the average central station man and incite free and fruitful discussion. And the result was, as might have been expected, a gratifying amount of discussion, despite the uninspiring attendance.

◆

Library of the A. I. E. E.

Through the generosity of Dr. S. S. Wheeler and Mr. Andrew Carnegie, the library of the American Institute has recently been so extended as to make it now perhaps the finest collection of electrical literature in the entire world. The late Latimer Clark of London, during 45 years gathered a great collection of electrical books, the titles in the English language being almost absolutely inclusive up to the year 1889. This collection was purchased by Dr. Wheeler and presented to the Institute at the May meeting. The matter of housing, cataloguing and completing the library having been brought to the attention of Mr. Andrew Carnegie, he at once donated for this purpose a fund equal to that paid by Dr. Wheeler for the collection, amounting to $6880.28. The catalogue to be prepared, a copy of which will be presented to every member of the Institute, will be of unique value. It will be compiled by a world-wide authority on earlier electrical literature, with each title followed by a note pointing out the specific features that give value to the work.

The Wheeler collection is particularly rich in the earlier works relating to electricity, containing almost all of the great rarities which were published during the first centuries after the discovery of the art of printing. Among these are the early works, principally in Latin, celebrated for the speculations contained on telegraphing, the identity of lightning and electricity, the lightning rod, etc. The completeness of the collection in this department may be surmised from the fact that it contains all of the very rare issues of Gilbert's "De Magnete," five in number. The collection is also of high value as a working library, containing as it does almost every modern work printed in English, French and German down to 1889 which relate to electrical science and engineering. The large number of sets, or partial sets, of electrical periodicals contained in the collection, added to those previously in the possession of the Institute, makes the library particularly valuable for reference. Indeed, it is quite probable that in a few years the Institute may boast of having on its shelves a copy of every electrical periodical that has been printed in the English language, and complete sets of all the leading periodicals printed in French, German and Italian. It may be added that a movement is now under way toward procuring for the library a complete set of United States electrical patents, and abstracts of all English, German and French electrical patents.

◆

Direct-Current Voltages.

The diversity of bases on which direct-current machinery is rated would be mildly ridiculous were it not for the inconvenience and, in some instances, injustice that are entailed. One builder bases the output of his dynamos on 110 and 220 volts, another on 120 and 240 volts, and still another on 125 and 250 volts. Railway generators are rated on 500, 550, 575 and 600 volts. Stationary motors are rated on 110 and 220, 115 and 230, 120 and 240, or 125 and 250 volts. In the name of common sense, why is there not more uniformity? It is sometimes argued plausibly that a machine rated at any one of a group of voltages, such as 110, 115, 120 and 125, will give its rated output equally well at any other voltage of that group. This is obviously an untenable argument if the machine is intelligently designed and properly rated. Machines rated at the lower voltages of the group may sometimes be made to give their output (and more) at a higher e.m.f. by speeding them up, but the reverse is by no means true. No matter what the actual working e.m.f. may be, there should be three definite standard voltages as bases of dynamo ratings and three for motors, the motor standards being, of course, lower than those for dynamos.

DESIGN FOR A 400-AMPERE ELECTROPLATING DYNAMO.

BY CECIL P. POOLE.

The drawings shown herewith illustrate the principal features of a dynamo designed for electroplating service and having an available capacity of 400 amperes at 8 volts. This machine is a modification of the 75-light dynamo the design for which was published in the January number of the American Electrician. As in the case of that machine, the field magnet is of the familiar radial pole type with a circular yoke provided with a partial "shrouding" on each side somewhat similar to the practice observed by the Crocker-Wheeler Company. The principal object of this shrouding is to give the machine a rather more finished appearance than it would have without it, and if any reader who may undertake to build the dynamo prefers to leave off this web, it may be done without affecting the operation of the machine.

Fig. 1 is an end view of the field-magnet frame minus the coils and journal boxes. Fig. 2 is a plan view of the frame, which shows the arrangement of the projecting feet that support the journal pedestals, and Fig. 3 is a sectional view on a transverse line through the center of the field-magnet structure. In order that the design may be available to a larger number of readers, cast iron has been adopted as the material for the field magnet instead of cast steel, which, of course, is the usual modern practice. The only machine work necessary on the field magnet is boring out the pole faces and tooling the seats for the journal pedestals, all of which must be done at one mounting of the magnet frame in order to insure accurate alignment between the armature chamber and the journals. Fig. 4 is a section of one magnet pole and the corresponding part of the yoke, taken on the line *C-D* of Fig. 1, and Fig. 5 is a cross-section of a magnet core taken on the line *A-B* in Fig. 3.

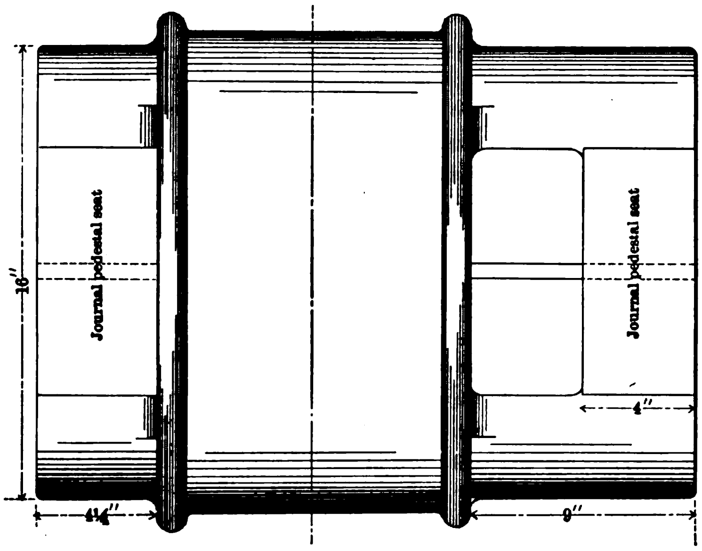


FIG. 2.—PLAN VIEW OF MAGNET FRAME.

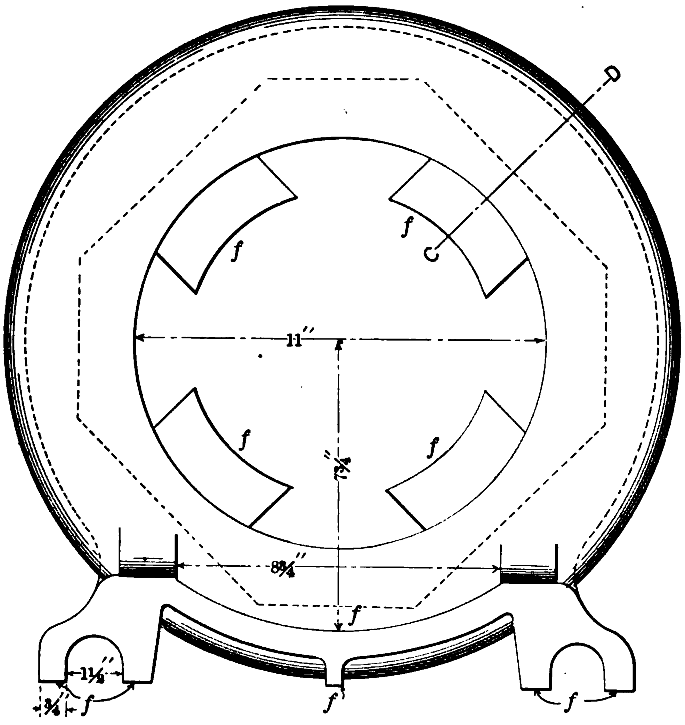


FIG. 1.—END VIEW OF FIELD MAGNET.

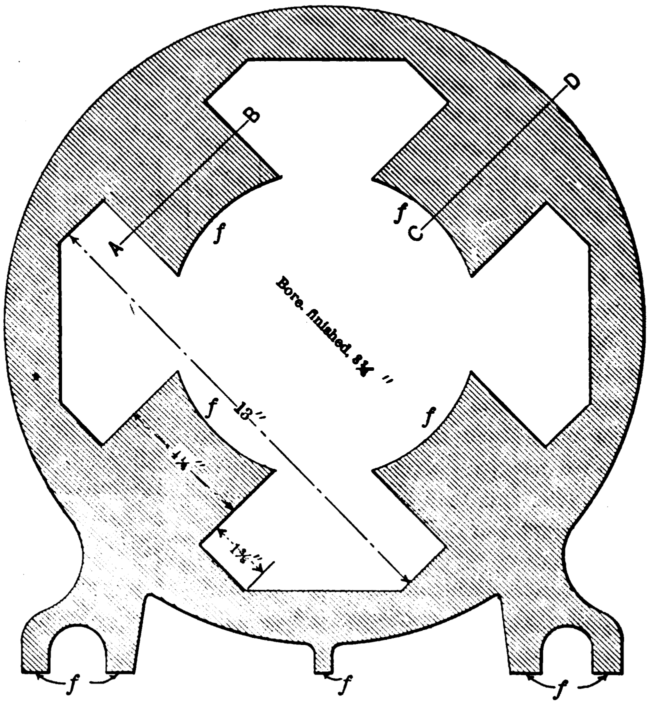


FIG. 3—TRANSVERSE SECTION OF FIELD MAGNET.

The dimensions of the magnet that are not shown in the drawings are as follows:

	Ins.
Extreme diameter of shell	17
Extreme diameter over the ribs	18¼
Distance between ribs	9
Thickness of each rib parallel with shaft	1
Total plan length of field magnet frame from outside to outside of journal pedestal seats	24½

Figs. 6 and 7 are sectional views of a journal box and pedestal, the former being an axial section and the latter a transverse section. The section of Fig. 6 is taken on the line *J-K* of Fig. 7, and the section of Fig. 7 is taken on the line *H-I* of Fig. 6. As the sketches plainly show, the bearing is of the oil-ring variety, with a circular reservoir, and the sleeve is perfectly straight, this type being much easier for an amateur to construct than a self-aligning bearing. If ordinary care is taken in cutting the seats of these pedestals and in turning off their bases, the bearings cannot fail to come in alignment without any special provision in the way of a swiveling bushing. The pedestals and journal boxes are of cast iron, of course, and the bushing may be made either of solid brass or of a thin seamless brass tube babbitted. On the inner end of one journal box a seat ½ in. long should be turned for the brush-holder yoke. The oil rings will be 2½ ins. in diameter, inside, 5/16 in. wide parallel with the shaft, and ⅛ in. thick, measured radially.

Fig. 8 shows the shaft and a sectional view of the armature core and supporting drum. This drum is a simple cylinder, *d*, 8 ins. in diameter outside when finished, and provided with a flange, *g*, at one end, which carries at its outer edge a drum or barrel, *b*. The function of this barrel is to support the projecting ends of the armature coils. The discs are mounted on the drum, *d*, and clamped in place by means of a ring, *r*, which carries a barrel, *b*, exactly like the one on the flange of the core drum. These flanges project 2½ ins. from the core discs. The ring, *r*, may be secured to the drum, *d*, by means of six 3/16-in. machine screws. The dimensions of the different parts of the shaft are marked on the sketch, as well as the principal dimensions of the armature core and spider; those which are not indicated are as follows:

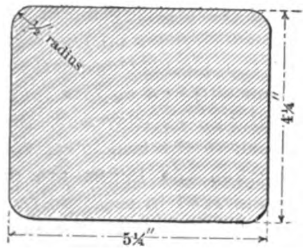


FIG. 4.—CROSS SECTION OF MAGNET POLE.

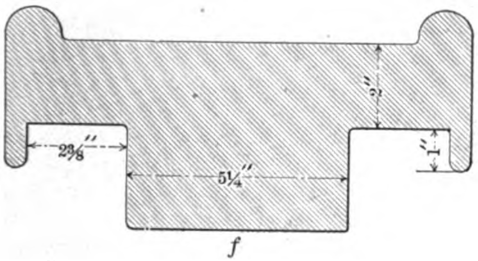
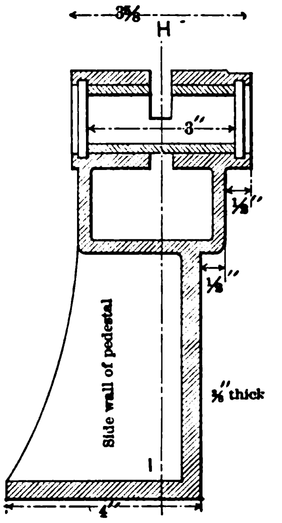


FIG. 5.—RADIAL SECTION THROUGH MAGNET POLE AND YOKE RING.

	Ins.
Diameter of armature discs......	8
Number of slots	32
Size of each slot......................	5/16 x 1 1/16
Diameter of extension barrels, b..	5¾
Diameter of core hubs, h.........	2
Extreme length of core drum from end to end of the hubs...	9¼
Diameter of core drums, d.......	3
Radial thickness of drum wall..	⅜
Thickness of flange, g, and ring, r, parallel with shaft	½

The commutator should be purchased from some of the standard manufacturers. Its extreme length along the shaft must not be over 4 ins. It must have 32 segments, and must be exactly 5 ins. in diameter. The width of the brush tread parallel with the shaft must not be less than 2½ ins., and the diameter from tip to tip of diametrically-opposite connecting lugs must be 7½ ins.

The machine is designed for four sets of copper brushes, opposite sets being connected together, of course, as in the case of all multipolar machines. Each set comprises two brushes, each ⅝ in. thick by 1 in. wide; the ends of the brushes must be beveled to such an angle as to give an actual contact surface ½ in. by 1 in. The builder can use his own judgment as to the type of brush-holder, although there is not much latitude when it comes to designing a brush-holder for copper brushes. It will be advisable to copy the design of brush-holder used on some standard machine.



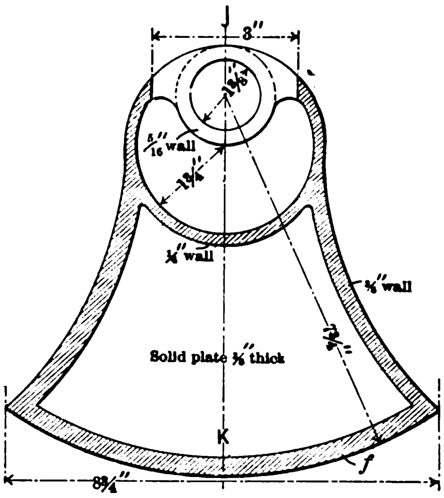


FIG. 6.—SECTIONAL VIEW OF JOURNAL BOX AND PEDESTAL.—FIG. 7.

The field winding of the machine consists of four coils of No. 11 single cotton-covered magnet wire wound 12 layers deep and 23 turns long parallel with the axis of the core, giving 276 turns per coil. If the builder is able to put more turns than this without exceeding a depth of 1 3/16 ins., so much the better, and the coil should not be deeper than this. The coils are connected up in the usual manner, so that the polarity of the magnet cores alternates, and a rheostat must be provided to regulate the field current. As in the case of the commutator, it is wholly inadvisable for an amateur to attempt the construction of his rheostat; consequently, no directions are given for this.

Each field coil must be taped with two layers of German-linen tape wound through the coil shuttle-fashion, so that the tape crosses the wires at right angles. Each layer of taping must be wound with a half lap, varnished and thoroughly dried, i. e., the first layer must be thoroughly dried before the second layer of tape is put on, and then the second layer must be varnished and dried similarly.

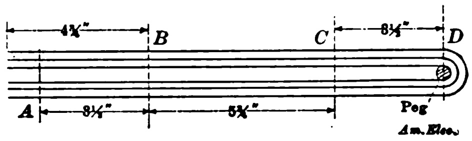


FIG. 9.—ARMATURE COIL BEFORE SHAPING.

The armature winding consists of 32 coils of No. 4 double cotton-covered magnet wire, two wires in parallel, each coil containing one turn. Fig. 9 shows an armature coil which, it will be seen, consists merely of two parallel wires looped around a ½-in. pin. After bending the

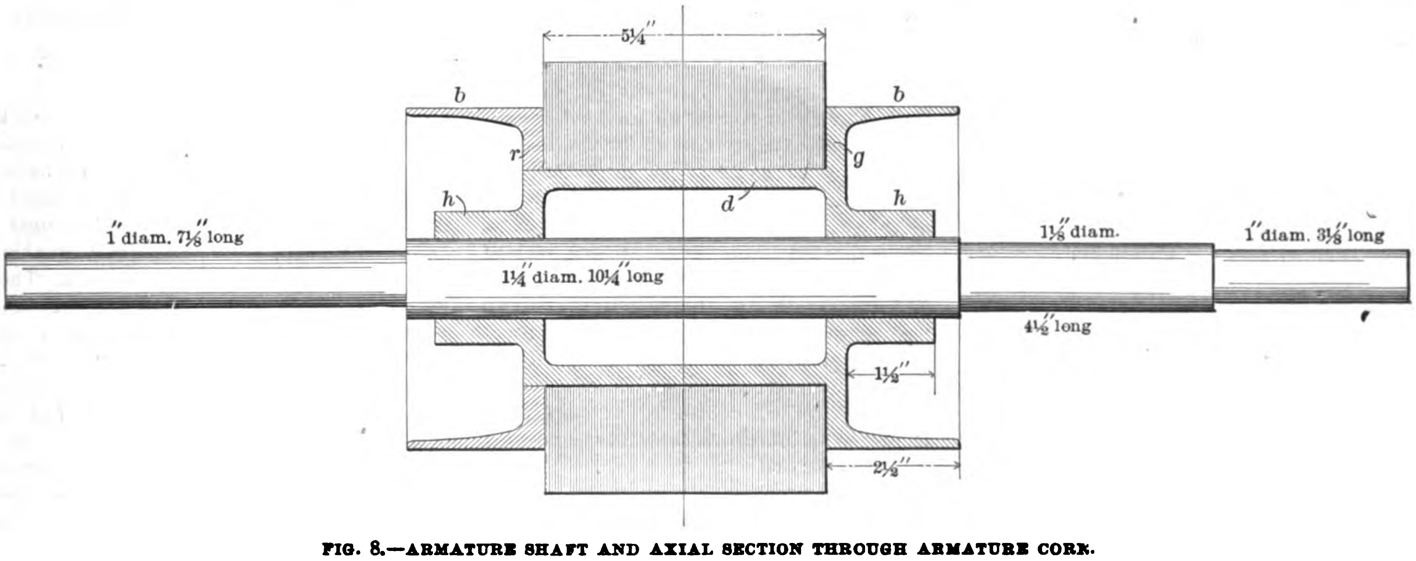


FIG. 8.—ARMATURE SHAFT AND AXIAL SECTION THROUGH ARMATURE CORE.

loop to shape it should be clamped across the bend at the line, *D*, and each side clamped individually at the points indicated by the lines, *C* and *B*; the bodies of the clamps here must be within the space between the two lines, so that the extreme outer edges of the clamp coincide with the lines *B* and *C*. Then the two sides should be bent apart until a plan view of the coil looks like Fig. 10. After it is in this shape it should be carefully taped with a single wrapping of German-linen tape, wound with a half lap, so as to give two complete thicknesses of the tape. After taping, each coil should be varnished with shellac or some other reliable armature varnish and baked until it is thoroughly dry.

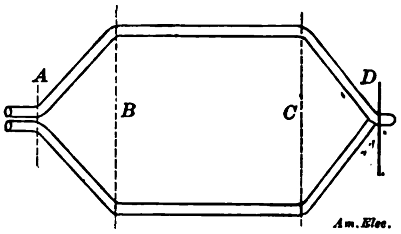


FIG. 10.—ARMATURE COIL, SHAPED.

The coils must be assembled on the armature core so that there will be eight teeth between the two sides of each coil. When the coils are all in position on the armature core they should be temporarily secured in place by two retaining bands of twine wrapped around the coil projections at each end of the armature. Then the coil connections should be carried to the armature, all of the under terminals being put in place first and followed by the upper terminals. The two terminals of each coil must be connected to neighboring segments of the commutator. Having put all the lower terminals in the commutator segments, the builder can start at any convenient place with the upper ends, and after the upper end of the first coil is put in the segment next to the lower end of the coil, all of the other upper ends follow in regular rotation, so that it is not necessary to test each coil, provided the under ends have all been inserted in proper rotation and that the upper terminal of the first coil is properly located.

STARTING ROTARY CONVERTERS.

BY ARTHUR B. WEEKS.

Among the many subjects discussed at the last street railway convention was that of rotary converters, which are coming into general use, especially for long-distance work. The following notes upon the rotaries illustrated herewith will give central station men generally some practical ideas on the subject. Fig. 1 is an illustration of a Westinghouse two-phase machine, and Fig. 3 shows a General Electric rotary. The Westinghouse rotary is a six-pole machine with a rated capacity of 375 kilowatts; the speed is 500 r.p.m., and the voltage 575 to 600 on the direct-current side. Alternating current is supplied to the rotaries at a frequency of 25 cycles per second.

The switchboard panel for the rotary is mounted on a rectangular iron frame, standing over an opening into a subway containing the transformers, fuses, field rheostats, and numerous cables and smaller transformers. At the top of the panel are the synchronizing lamps; below them are two alternating-current ammeters on the primary side. There are four motor-starting plug switches on the left, and the same number of alternating-current switches on the right of the panel; the latter serve to make connections between the alternating-current circuit and the primary terminals of the transformers that supply the rotary converter. The plug switches are shown closed in the engraving. Below these are the circuit-breaker and the main switch for the direct-current side. The motor at the extreme right of the rotary converter shaft is for the purpose of bringing the converter armature up to speed when starting. It must not run an unusual length of time, because it is built for the merely temporary work of starting the rotary and will overheat if required to drive the armature for a considerable length of time. There are collector rings at this end of the rotary shaft for the starting motor, and a lever on top of the motor, the two positions of which are marked "Starting" and "Running." At the direct-current end of the converter armature shaft is a coil of fine wire connected to an oscillator, the function of which is to give end play to the armature.

This machine may be started in either of two ways. When started from a complete shut-down, it is started on the alternating-current side as follows: With all panel switches open and the field rheostat wheel at the starting position, put on the motor collector brushes, and push in the two top motor plug switches; this connects the starting motor with one leg of each phase of the supply circuit. Push in the two lower ones next, which will connect up the motor with the other legs of both phases; should the armature not start promptly, pull on it slightly. When the speed reaches a point where no further increase is indicated by the sound, move the motor starting lever to the "Running" position; the speed will immediately increase. With a suitable voltmeter placed upon the stand on the panel, insert the terminals into the voltmeter receptacles; raise the direct-current voltage to 250 by means of the rheostat; push in the two top plugs on the right; as in the case of the starting motor, the plugs first inserted connect up one leg of each phase of the alternating-current circuit.

The lamps will now pulsate very rapidly, but will not go entirely out; the proper time to push in the two lower right-hand plugs is when the lamps are dimmest. Considerable skill is required to do this, but after a little practice it goes all right.

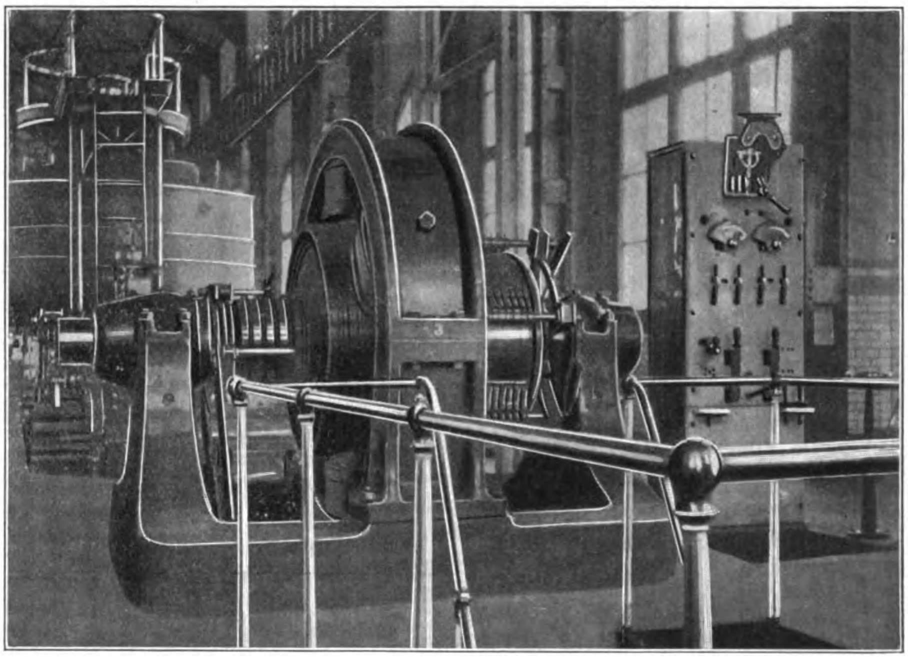


FIG. 1.—WESTINGHOUSE ROTARY CONVERTER IN THE NIAGARA FALLS POWER HOUSE.

Should the converter be thrown in circuit when slightly out of step, a serious flash at the commutator brushes will ensue, and must be attended to before proceeding further. When the machine is properly synchronized, close the circuit-breaker and the main direct-current switch. The starting motor must then be cut out, which is done by pulling out the two top motor plug switches together and quickly; then remove the two bottom plugs. The bottom plugs may be pulled first if it is preferred, but one should acquire the habit of doing it the same way each time. Pull the motor-starting lever to the "Starting" position, and lift the motor collector brushes. The rotary is now in proper working condition.

If the direct-current bus-bars are alive before the rotary is started up, it may be connected to that circuit first, proceeding in the following manner: After cutting in the starting motor as before, adjust the direct-current voltage a trifle higher than the running voltage, then close the circuit-breaker and main switch. Next put in the two top plugs on the right, and synchronize as before; this time, however, the lamps will go out when the converter is in synchronism. The lamps must be entirely out before the last two plugs can be put in; the ideal time is after they have gone out, and before they begin to come back. This is the critical moment, and one is naturally timid at first, especially after having heard the high-potential fuses blow, or circuit-breakers come out.

It sometimes happens that the starting motor of a rotary converter becomes disabled; it is then necessary to resort to another method of starting on the direct-current side, if the machine cannot lie idle while the repairs are being made. This method is to start the rotary as a direct-current motor, a water rheostat being used as a starting box; the connections are shown in Fig. 2. The direct-current switch as used ordinarily upon the panel has both blades operated together, by one handle, but for the present purpose they must be separated into two single-pole switches. To start, proceed as follows:

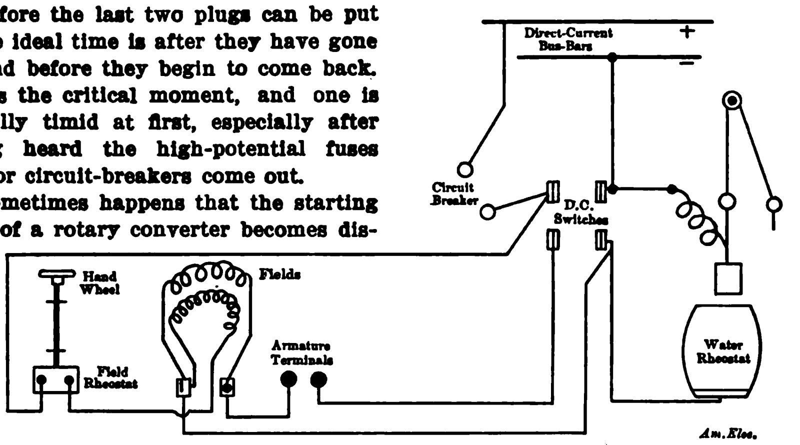


FIG. 2.—DIAGRAM OF CONNECTIONS FOR STARTING A ROTARY AS A DIRECT-CURRENT MOTOR.

(1) Cut out all resistance of the field rheostat; (2) close the circuit-breaker; (3) close the left-hand blade of the direct-current switch; (4) lower the water rheostat electrode slowly to the bottom of the barrel; (5) bring the armature fully up to speed by cutting in the field rheostat again; (6) close the right-hand blade of the direct-current switch; (7) put in the alternating-current motor plugs, as the connections to the converter for synchronizing are made here; (8) synchronize with the rotary plugs as before; (9) remove the water rheostat plate entirely out of the barrel.

An ordinary oil barrel may be used for the water rheostat, filling it within 6 or 8 ins. from the top. Throw considerable salt into the water to lower its resistance. A convenient way to handle the top plate of the barrel is to tie a rope to the plate and carry it over a small pulley above the barrel.

To shut down this converter, simply weaken the field slightly and open the circuit-breaker, then the main direct-current switch; next pull out the top alternating-current plug switches both together with a quick, straight pull; then remove the other two, following the order named, and turn the rheostat to the "off" position.

The pilot lamps on the rotary go out whenever the rotary circuit-breaker is out. This happens, as in the case of any direct-current generator, from an overload due to any cause. Connecting a rotary in circuit when it is out of step will probably throw out all the circuit-breakers of the other rotaries in parallel; if badly out of synchronism, it will also blow its own fuses. The machine is synchronized on the high-potential side, and when the fuses are blown there is no mistaking the noise for anything else. When a rotary blows its fuses and throws its own circuit-breaker and those of the other rotaries (the fuses of the other rotaries remaining intact), pull out the alternating-current plugs of this rotary at the panel, and close the circuits of the other rotaries by putting in the circuit-breakers first and the switches next. Then fuse up the rotary that caused the disturbance. Remove the fuse-blocks from their places and replace with new fuses in the same position as those removed, since it is possible to insert some fuse blocks either vertically or horizontally. Late improvements prevent this occurrence, but serious consequences have resulted from the old arrangement, as scarred faces and hands can testify. Before starting up a rotary one should make sure that the synchronizing lamps are always good and the circuit intact. The writer remembers a case where one of the synchronizing lamps was removed, probably as a joke. The converter fuse may also be out.

"Pumping," or "hunting," as it is termed, may still be met with in some rotaries. It comes on with a peculiar squeak and sparking of brushes, and comes and goes, increasing in severity if allowed to continue, until finally the circuit-breakers come out, or the alternating-current fuses let go. Hunting is usually brought on by an overload, when certain makes of rotaries are in parallel. Sometimes using different makes of rotaries in parallel prevents it. Opening the circuit-breaker of the feeder having the unusual load will stop the hunting immediately. In pulling off a rotary converter when it is hunting, one should watch the alternating-current ammeter closely, in order not to pull the plugs when the meter indicates an increasing current, but catch it when it is as low as possible, otherwise a very destructive arc is liable to follow the plugs. A later improvement consisting of copper shields around the pole-pieces is one remedy for hunting.

The General Electric rotary converter, shown in Fig. 3, is rated at 500 horse-power, and works in parallel with the Westinghouse rotary just described. Its instrument and switch panel are similar to those of the Westinghouse rotary, with the exception that the General Electric panel has its high-tension switches upon the face of the panel. At the top is a type "K" circuit-breaker; below it are the synchronizing lamps, then the alternating-current ammeters for each phase on the primary side. Below these are the alternating-current high-tension switches; next are the field switch, two main direct-current switches, and the starting switch, located between the two main switches. At the extreme right are receptacles for two plug switches for the synchronizing circuit. The rheostat wheel is upon a pedestal to

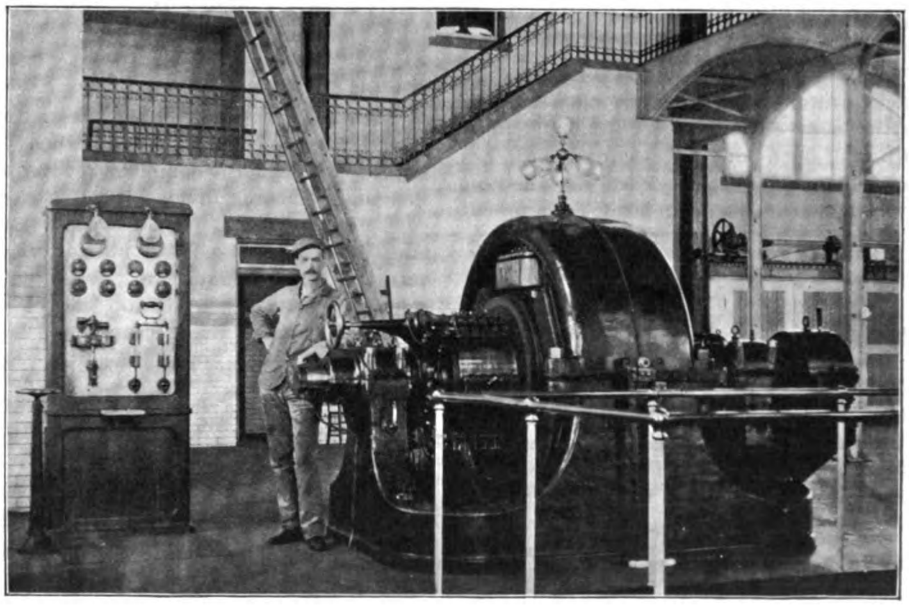


FIG. 3.—GENERAL ELECTRIC ROTARY CONVERTER IN THE NIAGARA FALLS POWER HOUSE.

the right of the panel, and its rheostat is in the subway. Here also are the air-blast transformers which supply this rotary.

To start this machine on the direct-current side, proceed as follows: Start the induction motor that drives the fan blower for cooling the transformers; next close the circuit-breaker and the field switch, then the left-hand direct-current switch; then close the starting switch. When the armature is up to speed, close the right-hand direct-current switch and open the starting switch; then close the two secondary switches which are mounted on the rotary frame below the alternating-current collector rings. In closing these switches, turn the face to one side, as there is frequently an arc both at the switch and the alternating-current rings when the switches are closed. Put in the synchronizing plug switches next. There now remain but the four primary alternating-current switches to be closed. They may be numbered 1, 2, 3 and 4, commencing at the left; close 1 and 3, which connect up one leg of each phase. To synchronize, wait after adjusting the voltage, until the lamps are out; then close switches 2 and 4, both together, with a quick firm movement. Now remove the synchronizing circuit plug switches. If the circuit-breaker comes out when closing switches 2 and 4, simply reclose the circuit-breaker. Since these four switches are upon the front of the panel, great care is necessary in handling them, as they are in the high-tension circuit. Later improved switches are operated by handles on the front of the panel, and the switches themselves open and close in an oil chamber back of the panel, relieving the attendant from the possibility of being burnt.

Any transformer troubles are manifested immediately, and when they occur the rotary should be taken out of circuit at once. To do this, weaken the field slightly and open the circuit-breaker; place the field switch on the center, open quickly alternating-current switches 2 and 4, then 1 and 3; open both direct-current switches and the field switch. Turn the rheostat wheel to the starting position, and cut out the induction motor.

BRUSH-HOLDERS AND BRUSHES.

When once the position of the brush-holders of a rotary converter is properly adjusted, they should not be moved from that position, otherwise a serious mix-up is liable to ensue. Some makes and qualities of carbon brushes will be found to work better than others. At Niagara Falls it has been found that with graphite carbon in the negative holders and the regular make in the positive holders excellent results have been obtained. Graphite should not be used exclusively, for if the rotaries are heavily loaded severe arcing will follow and burn the carbons out in a very short time. Not a little arcing of some carbons can be avoided by having first-class carbon-holders with flexible leads between the carbons and the body of the brush-holder. If for any reason the holders are removed, one may find pieces of sheet copper and paper under one side which have been placed there to line the carbon-holders with the commutator segments, since the carbon-holders are apt to drop down at the farthest corner, perhaps ¼ in. Continual chattering of carbons crystallizes the holders, and parts may sometimes be cracked almost far enough to allow the piece to fall off. Again, the arcing between the carbon and the metal due to poor contact in the holders which have no flexible leads eventually weakens such parts.

◆

READING A RECORDING WATTMETER.

The reading of recording wattmeters of the Thomson type has always been a more or less difficult task to the uninitiated, whereas it should be a matter of comparative ease did one fully grasp the significance of the dials and the relation each bears to the others.

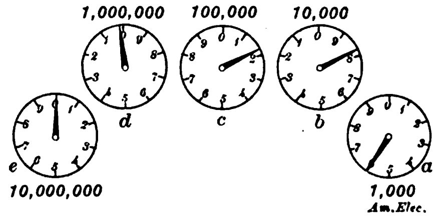


FIG. 1.

Meters, as usually furnished, have five dials, and are so geared that the pointers of the first, third and fifth dials register clockwise, and the second and fourth register counter-clockwise, or *vice versa*, as the case may be. The dial at the extreme right registers one kilowatt when the pointer has made a complete revolution; and the dial being divided into ten parts, each division represents 100 watts. Each succeeding dial, it will be noticed, registers ten times as much as the preceding one, and hence each pointer moves ten times faster than its successor.

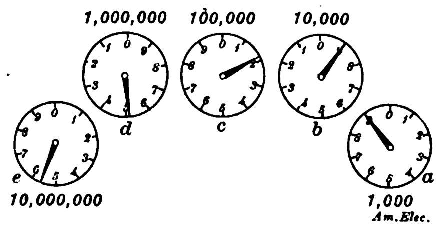


FIG. 2.

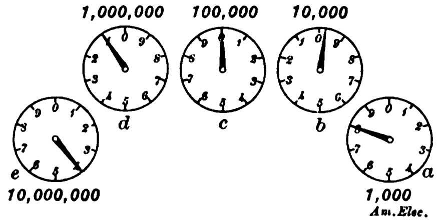


FIG. 3.

When reading a meter one should always read the lower figure of the two between which the pointer lies, even though the pointer may be nearer the higher one. The reason for this will be shown in the examples given further on. The problems selected are as difficult as any met with in practice and will be found to cover every point. The ability to correctly read the indicated wattage places one in a position to successfully cope with any problem in wattmeter reading, and a little practice should result in such a proficiency that one would be able to read the dials as rapidly and intelligently as one would read a row of figures, and with the same degree of accuracy.

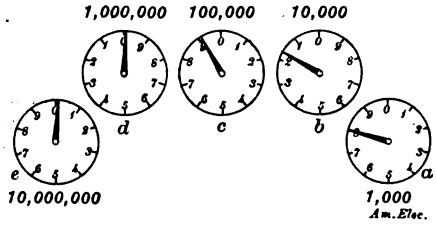


FIG. 4.

In the illustrations given, the different dials will be referred to as *a*, *b*, *c*, *d* and *e*, beginning at the right, as indicated in Fig. 1. The meter shown here is read as follows: The pointer of *a* being directly over 6 the reading is 600. The pointer of *b* being between 8 and 9 the reading is 8000. *c* is read 10,000, and the pointers of *d* and *e* not having gone through their first divisions no attention is paid to their indications. The indicated wattage is then 16,600, which, when multiplied by the constant of the meter, gives the watt-hours to be paid for.

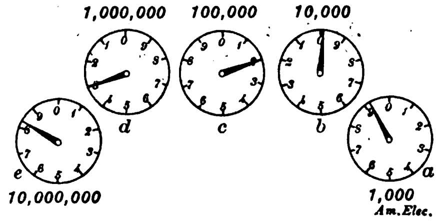


FIG. 5.

The reading indicated on the meter shown by Fig. 2 is 5,518,900 and not 5,519,900, as one might suppose; because the pointer of *b* should not indicate 9000 until the pointer of *a* has completed its revolution and is at zero or slightly beyond.

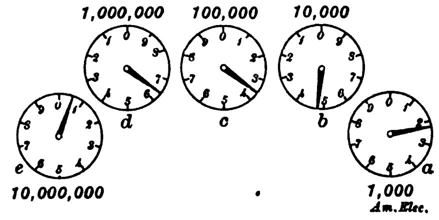


FIG. 6.

The meter shown by Fig. 3 indicates 4,099,800 and not 4,109,800 as it might easily but erroneously be read. The reason is apparent on a little thought. The pointer of the dial *c* cannot rightly indicate zero until the pointer of *a* passes from 8 to 0; then the pointers of *b* and *c* will be at zero, the pointer of *d* at 1, and the pointer of *e* just past the zero mark.

The reading of the meter shown in Fig. 4 is 9,991,800. It will be noticed at a glance that the pointer of *e* is slightly misplaced; otherwise the same reasoning applies to this as to the preceding readings. The meter shown by Fig. 5 indicates 8,319,900. Here again the not uncommon fault of misplaced pointers is met with. The pointer of *d* is misplaced; for since each pointer travels one-tenth as fast as its predecessor and inasmuch as the pointer of *c* registers 2, the pointer of *d* should be two-tenths of the way between 3 and 4 instead of at 3 as shown.

In the meter shown by Fig. 6 the reading is 635,200 and not 634,200 as indicated; the pointer of *b* is misplaced. The reading on *a* shows that the pointer of *b* should be two-tenths of the way between some two points, and reference to dial *c* shows that it should be between 5 and 6; for since a movement from 3 to 4 on *c* corresponds to a movement from 0 to 0 on *b*, and inasmuch as the pointer of *c* is over half way between 3 and 4, it is evident that the pointer of *b* should have passed over hair way around the dial and hence beyond 5.

As pointed out in the explanation relating to Fig. 1, the indicated watt-hours must be multiplied by the constant, or correction factor of the meter, in order to ascertain the watt-hours to be paid for; the difference, of course, between the last reading and the one preceding it gives the watt-hours used during the time which has elapsed between the two readings.

* * *

COMMON BATTERY TELEPHONE SYSTEMS.

BY W. S. HENRY.

In my article in the June American Electrician Fig. 14 was erroneously called "One of the Bell company's common-battery systems." This diagram does not illustrate a Bell system, but shows in principle, at least, a system used by one of the prominent independent telephone companies.

Fig. 16 shows a diagram of connections of a small common battery system installed a few years ago by one of the independent telephone companies. Impedance coils, *I I*, or something equivalent to them, are connected in circuit with the common battery, *B*. In house or factory systems three wires run from the switchboard to each telephone, but the ground may evidently be used in larger exchange systems as one wire of the signaling circuit. Three wires are shown running from the switchboard to the desk set, *A*, and to the wall set, *C*, and two wires with the ground as a third path into the switchboard with the wall telephone set, *B*. No attempt has been made here to give the exact arrangement of the hook switches and other apparatus in the telephone sets, *A*, *B* and *C*, because it is simpler to illustrate them in the manner shown in this figure.

This switchboard has no ringing key for each cord circuit; the ringing of the bell at the called subscriber's station is accomplished by pushing the calling plug as far as it will go into the jack, as shown at the jack, *Ja*, there being a spring (not shown in the figure) that pushes the plug out to its normal position in the jack as shown at *Jb*. The line drops, *Da*, *Db* and *Dc*, are constructed and operated in the same manner as described and shown in Fig. 14 in the June article. If the hand generator is used for ringing, the switch, *Sw*, rests on *n* and the ringing key, *Rk*, is depressed each time a subscriber's bell is to be rung. The jack has three independent springs, as clearly shown at *Jc*. Normally, the spring *dc* rests on the metal piece *lc*, in order to keep the signaling circuit through the line drop *Dc* closed at the switchboard. However, there is no current through either coil on the drop *Dc* as long as the subscriber's push *Kc* is open. The two metal parts, *fc* and *lc*, of the jack are insulated from one another, *fc* being connected to one side of the drop and *lc* to one side of the generator.

Each plug has its tip, *t*, connected to the tip strand of the cord circuit, its sleeve, *s*, to the sleeve strand, and the metal collar, *d*, is insulated from all other parts of the plug, and for that reason it is called a "dead collar." When a plug is pushed into the jack as far as it will go it takes the position shown at the jack *Ja*, and rings the subscriber's bell, as will be explained later; but as soon as the pressure of the operator's hand is removed, the plug moves out a little way and takes the position shown at the jack *Jb*.

Suppose that subscriber C desires to call up the exchange. By closing the key, *Kc* current will flow from the signaling battery, *SB*, through line 2*c*, key *Kc*, to line 1*c*, one half of the winding of the drop, *Dc*, and back to the battery, *SB*, and thus operate the drop. When the shutter falls the operator inserts the answering plug into the jack, as shown at the jack, *Jb*, and closes her listening key, *L*. The insertion of the answering plug into the jack, *Jb*, connects the sleeve strand of the cord through the spring, *hb*, to the line 1*b* and the tip strand through the tip of the plug and tip spring, *gb*, to line 3*b*. The operator's set and the transmitter, *T*, and primary, *p*, of the induction coil at the subscriber's station are now in series with the two line wires, 1*b* and 3*b*, and hence the operator can ask for and receive the number of the subscriber with whom *B* desires to be connected. If subscriber *B* calls for subscriber *A*, the operator inserts the calling plug into the jack, *Ja*, pressing the plug in as far as it will go. This will put the plug and jack springs in the position shown at *Ja*. Current from either the hand or power generator will now flow through *fa*, the metallic collar, *d*, on the calling plug, spring *ha*, line 1*a*, bell, line 3*a*, spring *ga*, tip of the plug, spring *ga*, and back to the generator. Thus the bell of the subscriber is rung by merely pushing the plug into the jack as far as it will go. When the operator releases the plug a spring causes it to be pushed out a little and, connections similar to those shown at *Jb* being made, the two subscribers, *A* and *B*, can now converse over the two line wires, 1 and 3.

When the conversation is finished the subscribers hang up their receivers and ring off by pressing the push buttons, *Kb* and *Ka*. Suppose the push button, *Kb*, is closed, then current will flow from the battery, *SB*, through one half of *Db*, metallic piece, *lb*, line 1*b*, push *Kb*, ground or line 2*b* and back to the battery, *SB*. The shutter of the drop will fall, thus notifying the operator that the conversation is finished and the plugs can both be withdrawn from the jacks.

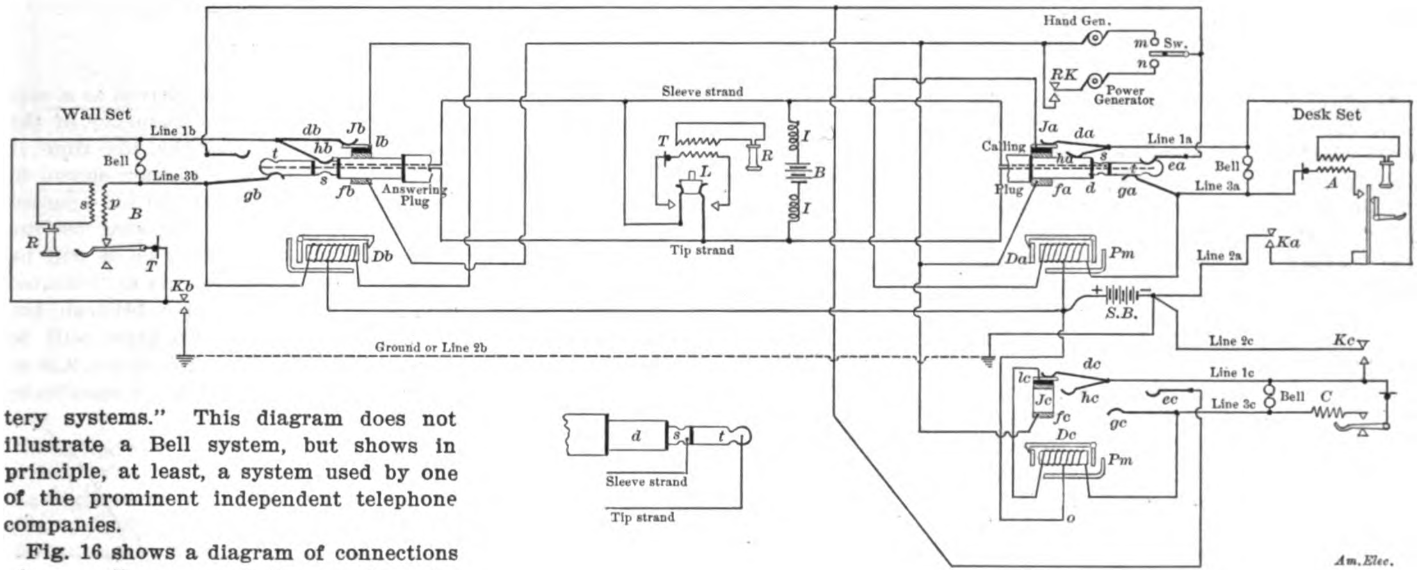


FIG. 16.—DIAGRAM OF CONNECTIONS FOR A SMALL COMMON BATTERY SYSTEM.

The bells at the subscribers' stations should be of high resistance and impedance. The primary of the induction coils are said to be about one ohm or less and the secondary about 75 ohms. The polarized bell used by the same company has, in some cases at least, a spiral spring attached to one side of the armature. This may be used to prevent a single stroke or ring of the bell being produced when the subscriber presses the push button or when the operator inserts a plug in a jack to answer a call. This explanation is merely offered as a suggestion. The spring, if not too strong, would not interfere with the ringing of the bell by the regular alternating ringing current.

Lessons in Practical Electricity

THE SYNCHRONOUS MOTOR.

If an ordinary alternating-current dynamo be driven at normal speed by some extraneous source of motion, with its field separately excited by direct current, and then connected to an alternating-current circuit at some instant when its impulse of e.m.f. coincides exactly with that of the circuit, the connection with the source of motion may be removed and the machine will continue running, being now driven as a motor by current from the circuit. Such a machine is a synchronous motor. This type of motor is like a direct-current motor in one respect, and only one, to wit: its construction is, fundamentally, exactly like that of the dynamo that generates the sort of current on which it (the motor) is designed to operate.

Synchronous motors run at precisely the same rate of speed as that of the alternator supplying the circuit on which they run, if the number of magnet poles is the same; hence their name "synchronous." If the poles differ, then the relation between the speeds of the motor and the generator is given by the simple equation

$$P\,S = p\,s \ldots\ldots\ldots\ldots\ldots (1)$$

in which *P* represents the number of poles on the generator; *S*, its speed; *p*, the number of poles on the motor, and *s*, its speed. The formula is obviously transposable four ways, according to which of the four values one wishes to determine. If *S* be expressed in revolutions per second, the frequency, *n*, of the current supplied by any alternating-current generator is equivalent to $P\ S \div 2$, and the relation between the speed of a synchronous motor and the frequency of the current that drives it is expressed by the equation

$$2\,n = p\,s \ldots\ldots\ldots\ldots\ldots (2),$$

from which obviously follow the formulas

$$\frac{2\,n}{p} = s, \quad \text{and} \quad \frac{2\,n}{s} = p.$$

The truth of the foregoing statements may be demonstrated by elementary diagrams, such as Figs. 1 to 7. Here, for the sake of simplicity, a bipolar field magnet and single-coil armature are shown. Suppose the armature to be driven by a belt at such a rate that the armature makes precisely one revolution while the current wave of the supply circuit passes through precisely one cycle; then, if the armature be properly connected to the circuit, it will occupy the position in Fig. 1 when the supply current is at its maximum (neglecting for the present counter e.m.f., inductance, etc.), as indicated by the Roman numeral, I, on the current wave, Fig. 7. The armature connections having been properly made, the supply current will induce poles at the periphery of the armature core, as indicated by the letters *n* and *s*, so that there will be a pull between the magnet poles and the armature core, tending to assist the rotation of the latter. When the armature core has passed through one-quarter of a revolution, and reached the position shown in Fig. 2, the current will have passed through one-quarter of its cycle and reached zero, as indicated by the numeral II in Fig. 7.

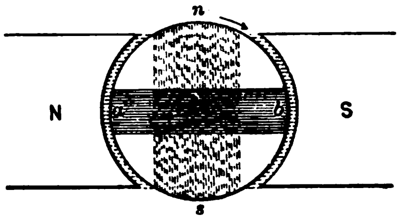


FIG. 1.

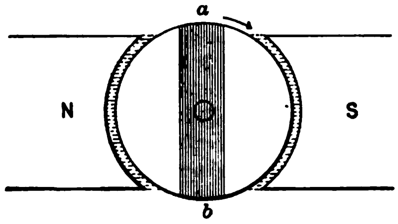


FIG. 2.

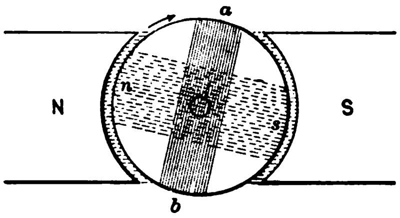


FIG. 3.

In this position the armature will not have any magnetic poles, but an instant later, when the coil has passed the vertical position, as indicated in Fig. 3, the current will have begun to rise in the opposite direction, as indicated by the numeral III in Fig. 7, producing reversed poles on the armature periphery, and resulting in a repulsion between the armature core and the field-magnet poles which renews the rotatory effort in the same direction as before. When the armature reaches the position shown in Fig. 4, having made exactly half a revolution, the current will have attained its maximum direction again, and this series of changes is continued so long as the armature revolves at the rate of one revolution per cycle of current. It is evident that under these conditions the armature does not need to be driven by any external source, as the magnetic torque between it and the field poles will cause it to continue to revolve.

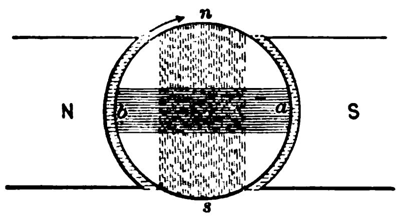


FIG. 4.

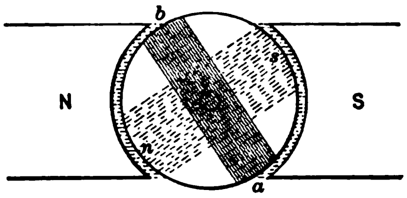


FIG. 5.

Should the speed of the armature be either less or more than the frequency of the supply current, the angular or tangential effort between the field-magnet poles and the armature core will be alternately favorable and unfavorable to the direction of rotation. For example, if the armature in passing from the position shown in Fig. 4 should be driven at a rate of speed lower than the frequency of the supply current, so that by the time it reaches, let us say, the position shown in Fig. 5, the supply current will have passed zero and reversed, as indicated by the numeral V in Fig. 7, then poles will be induced in the armature core as indicated in Fig. 5, and the torque between the magnet poles and the armature will be opposed to its direction of rotation. Again, if the speed of the armature should be more rapid than the rate of current reversals to such an extent that it would be driven from the position in Fig. 4 to that in Fig. 6 before the current had reached zero, as indicated by the numeral VI in Fig. 7, the polarity of the armature will again be such that the field mag-

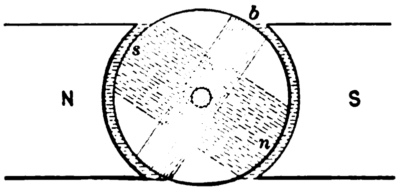


FIG. 6.

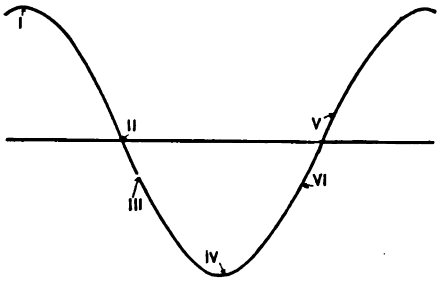


FIG. 7.

netism tends to pull it in the opposite direction. It is evident, therefore, that in order to maintain continuous torque in the same direction between the armature and field-magnet poles, the armature speed must be kept precisely in step with the current reversals. So long as the load on the armature is within its torque ability, it will maintain synchronous speed, but the moment the drag due to the load exceeds that exerted between the magnet poles and the armature, its speed will be reduced, it will drop out of step with the supply current, and come to a standstill.

Letters on Practical Subjects

A Problem in Connections.

To the Editor, American Electrician;

Sir:—Referring to Mr. Moutonnet's wiring problem in your May number, I wish to submit the solution indicated by Fig. 1. The switches are shown as double-pole and triple-pole strap switches, but of course this is merely diagrammatic as strap switches are not used for incandescent working. Assuming the switch, *C*, to be thrown to the left, throwing the switch *D* to the right will light the lamp *A*. Leaving the switch *D* in this position and moving the switch *C* to the central position shown in the sketch will cut out the lamp *A*, and this lamp may be relighted, of course, by throwing the switch *C* back to the left, while both lamps may be lighted by throwing it over to the right. With both lamps lighted and the switch *C* over to the right, throwing the switch *D* to the center will extinguish them, and throwing it to the left will light the lamp *A*, of course, which is the beginning of a new cycle. In other words, with the switch *C* in either the left-hand or right-hand position the switch *D* will light either the lamp *A* alone or both of the lamps, according to the side to which it is thrown. Arthur Barthels.

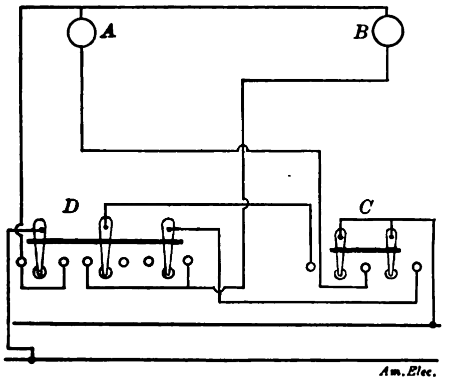


FIG. 1.

San Francisco, Cal.

To the Editor, American Electrician;

Sir:—Enclosed herewith is a sketch of connections of knife switches which I think will solve the problem submitted by Mr. George Moutonnet on page 239 of the May American Electrician. The switch *C* is a single-pole double-throw switch with three contacts, and the switch *D* is an ordinary double-pole double-throw switch.

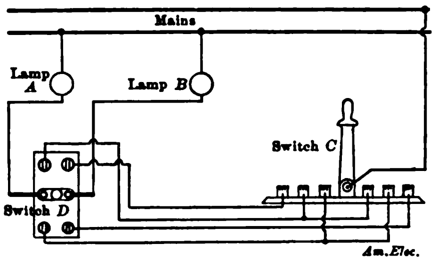


FIG. 2.

With the switch *C* thrown over to the left, throwing the switch *D* upward will light both of the lamps, and throwing it downward will light the lamp *A* alone. With the switch *C* thrown over to the right, throwing the switch *D* upward will light the lamp *A* alone, and throwing it downward will light both lamps. With the switch *D* closed upward, throwing the switch *C* to the left will light both lamps, and throwing it to the right will light the lamp *A* alone. With the switch *D* closed downward, the switch *C* lights the lamp *A* when thrown to the left, and both lamps when thrown to the right.

Marion, Ohio. W. P. Jackson.

To the Editor, American Electrician;

Sir:—The enclosed sketch is submitted as a solution of Mr. Moutonnet's problem which appeared in the May number of the American Electrician. The switches are shown diagrammatically, but it is assumed that they are of such construction that neither switch can be left out of contact with some of its connections. With the switches as shown in the diagram both lamps are lighted. By turning the switch *C* one point to the right the lamp *A* will be lighted alone, and by turning it to any of the other points both lamps will be extinguished. By putting the switches on different points all of the combinations required can be obtained, and with the lights both out either the lamp *A* or both lamps can be relighted from either switch.

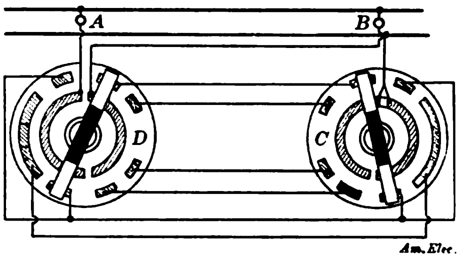


FIG. 3.

Brooklyn, N. Y. H. L. Francis.

To the Editor, American Electrician;

Sir:—The following arrangement of connections I believe fulfills the requirements of Mr. Moutonnet's problem in the May issue of the American Electrician. The switches *C* and *D* in this case are assumed to be four-point snap switches, each switch having a blade wide enough to bridge over the pair of contacts on each side of the center when thrown to the extreme left or right. When the blade of the switch *C* is turned to the right it first rests on the contact *a*, as shown, and may then be thrown still farther, so as to make contact with *a* and *b*. The same is true of the contacts *a′* and *b′* when the blade is thrown to the left, but the arrangement of the switch must be such that it cannot be left in the intermediate position. When the switch *C* is thrown to either the contact *a* or *a′* the switch *D* will light either the lamp *A* or the lamp *B* alone or both the lamps. If the switch *C* is thrown still farther, so as to bridge *a b* or *a′ b′* the switch *D* will light either the lamp *B* alone or both of the lamps. With the switch *D* on either contact *a* or *a′* the switch *C* will light either the lamp *B* alone or both lamps. This arrangement requires the two switches to be connected by three conductors, which is the least number that can be employed with this form of switch. Edwin Place.

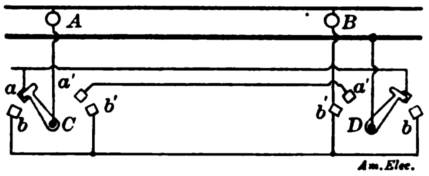


FIG. 4.

Schenectady, N. Y.

[All of the foregoing letters were received before the actual issuance of the June number, but too late for insertion in that number along with the earlier solutions.—Editor.]

Storage Battery Plate Surface.

To the Editor, American Electrician;

Sir:—I noticed in your May issue an inquiry from "F. N." as to the number of square inches of positive surface required in a storage battery for one ampere discharge. You answered that it was "About eighteen"; apparently this was based on simply the superficial area, and at an eight-hour discharge rate. While your answer is approximately correct so far as the superficial area goes, it is rather misleading. If the contact area of the active material with the support plate is considered, the ratio is much higher than that given in your answer. A positive plate measuring 15½ x 15½ ins. of the type manufactured by the Gould Storage Battery Company has a superficial area of 480 sq. ins., and the normal discharge of this plate for eight hours is 25 amperes, giving about 19 sq. ins. per ampere discharge. But a plate of this capacity has a *contact surface area* of 5000 sq. ins., so that the actual number of square inches per ampere discharge is increased to 200.

Increasing the contact area has a very marked effect on the capacity, and the higher the rate of discharge up to a certain limit, the greater is the efficiency. A plate with the same superficial area of 480 sq. ins. when "spun" so that the contact surface is 4000 sq. ins. has a capacity of 20 amperes for eight hours, but when increased by finer spinning to a surface of 5000 sq. ins., an exact increase of 25 per cent, the current discharge for eight hours is increased in the same proportion. Thus the capacity at a low rate of discharge is exactly in proportion to the increased *contact surface*; but whereas the plate with its first spinning when discharged in one hour had a capacity of 80 ampere-hours, the increase at the higher rate is not in the same proportion, but amounts to 115 ampere-hours, an increase of 43 per cent instead of 25 per cent.

Thus you will see that in the plate with 5000 sq. ins. of contact area, at the eight-hour discharge rate, the superficial area was 19 sq. ins. per ampere, while the contact area was 200, and at the one-hour rate the former became 4.14 sq. ins. and the latter 43 sq. ins. per ampere.

The above facts prove that the capacity at high rates of discharge is dependent not so much on the mass of active material as on the contact area of that active material with its support plate.

Wm. W. Donaldson.

New York, May 20, 1901.

Electrical Catechism

616. How is the electric furnace used?

The high degree of heat obtained is used in effecting chemical combinations of various materials. In some cases the elements of the different ingredients simply combine to form new combinations. At the high temperatures attained in the electric furnaces, the ingredients dissociate, that is, separate so that the elements are free to form new combinations. In such cases the current is simply the source of heat and does not directly enter into the reactions. In other cases the current not only furnishes a high temperature, but also takes direct part in the reactions and both the heating and the chemical effects of the current are used.

617. Give examples of electric furnaces in which simply the heating effect of the current is used.

The various carbides are well-known examples, especially calcium carbide from which acetylene is made, and carbide of silicon or carborundum. Electric furnaces for smelting or reducing ores have been reported from time to time, but seem not to have come into general use.

618. How is calcium carbide made?

Calcium carbide is formed by the union of carbon and calcium at a high temperature. The calcium is obtained from common lime, which is calcium oxide and is represented chemically by the symbol, CaO. When this is ground fine and well mixed with powdered coke (carbon), the latter unites with both the elements in the lime, two atoms of carbon uniting with one atom of calcium to form calcium carbide (CaC_2), other atoms of carbon uniting with equal numbers of atoms of oxygen to form a gas known as carbon monoxide (CO). The carbon monoxide escapes from the furnace and unites with the oxygen of the air, burning with a blue flame and forming carbon dioxide (CO_2) which is more familiarly known as carbonic acid gas. The reaction is expressed by the chemical equation,

CaO (calcium oxide) + 3C (carbon) = CaC_2 (calcium carbide) + CO (carbon monoxide),

which is read: One molecule of calcium monoxide unites with three molecules of carbon to form one molecule of calcium carbide and one molecule of carbon monoxide. The calcium carbide is a bluish gray structureless mass easily crumbled to powder. It unites greedily with water forming acetylene gas (C_2H_2) and slacked lime ($Ca (HO)_2$, the reaction being expressed by the formula:

CaC_2 (calcium carbide) + $2H_2O$ (water) = C_2H_2 (acetylene) + $Ca (HO)_2$ (calcium hydroxide).

Acetylene is a colorless and highly explosive gas with a very disagreeable smell, burning with a brilliant light, but apt to give a smoky flame. It can be liquified at a pressure of about 725 pounds per square inch at the temperature of freezing water. It is coming into extensive use as an illuminant.

619. How is carborundum made?

Carborundum is made in an electric furnace from a mixture of sand, coke, sawdust and salt. The real action is between the sand, which is oxide of silicon ($Si O_2$) often called silica, and the carbon in the coke and sawdust. The sawdust makes the mixture porous to facilitate the escape of gases, and the salt seems to act as a sort of flux. At the high temperature the silica is dissociated, its silicon uniting with carbon to form carbide of silicon (Si C) and its oxygen uniting with other carbon to form carbon monoxide (CO), which then unites with more oxygen from the air and burns into carbonic acid gas (CO_2). The formulæ are:

$Si O_2$ (silica) + 3C (carbon) = Si C (carbide of silicon) + 2CO (carbon monoxide); CO (carbon monoxide) + O (oxygen) = CO_2 (carbonic acid gas).

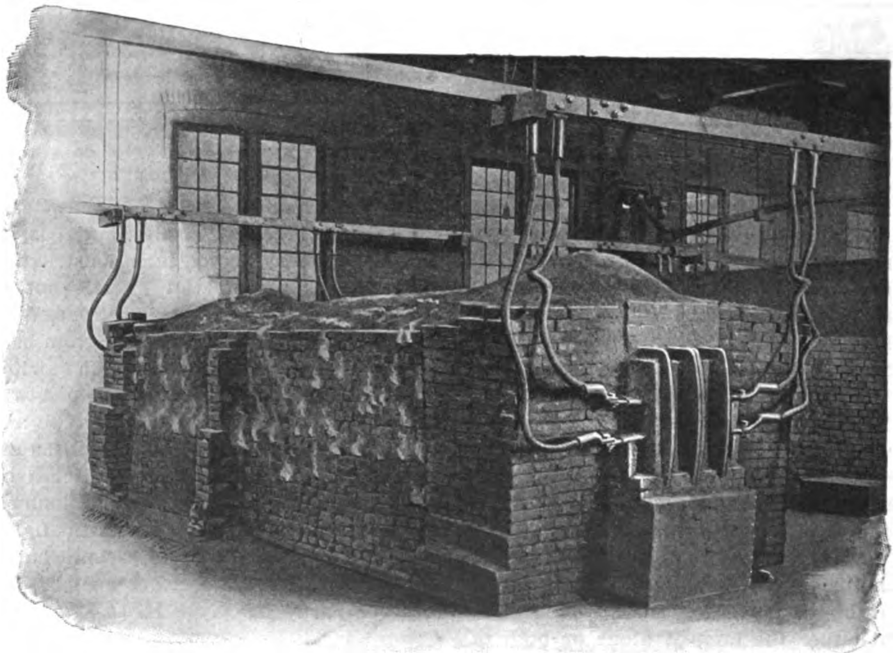
The carbide of silicon, or carborundum, forms in small flat thin crystals of beautiful colors. These are crushed and made into various shapes for abrasives, doing much of the work for which emery was formerly used.

620. In what sort of electric furnace is carborundum made?

As used by the Carborundum Company at Niagara Falls, the furnace walls are of brick, being about 16 ft. long, 5 ft. wide and 5 ft. high, the ends being of brick about 2 ft. thick. In the center of each end are the terminals, each consisting of 6 carbon rods 30 ins. long and 3 ins. in diameter, attached to an iron plate. A central core between the two sets of carbon rods is made of coke surrounded by the mixture of sand, coke, sawdust and salt, making a cylinder about 21 ins. in diameter and 14 ft. long. The side walls, which are taken down at each charge, are then built up and the remaining space is filled with the mixture. Current of something more than 1000 amperes at 100 to 250 volts is then sent through the furnace for about 24 hours. This furnace works on the incandescent principle, there being no true arc present.

621. What kind of current is used in electric furnaces?

Either direct or alternating current may be used in incandescent and in some of the arc furnaces. Only the direct current can be used in furnaces dependent partly or wholly upon the chemical effect of the current, as in the production of aluminum.



FURNACE USED IN THE MANUFACTURE OF CARBORUNDUM AT NIAGARA FALLS.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

Is it necessary to consider the polarity of telephone receiver connections in a common battery system having a condenser in the receiver circuit? F. A. G.

No.

Why are carbon brushes not used on arc machines? (2). What is the voltage of a gravity battery cell? B. S. S.

Because no advantage would be derived. (2). About 0.9 volt.

Can the armature winding of the 75-light dynamo described in the January number be connected in parallel (lap connection) and used with four sets of brushes to give 55 volts and 87 amperes? H. H. B.

Yes.

Which is the correct reading of a U-shaped chimney draft gauge; simply the rise in one leg or the rise in one leg added to the fall in the other? C. A. D.

The distance between the two levels is the correct reading; this is equivalent to adding the rise in one leg to the fall in the other.

What is the function of the small disc that some makers use in front of the arc of a searchlight? O. A. R.

The disc reflects rays from the arc to the parabolic reflector at such an angle that they are thrown back into the space which would otherwise be shadowed by the carbons.

What is the best insulation for use in an induction coil, beeswax, paraffine or boiled linseed oil? G. H. B.

These materials rank as follows: (1) oil, (2) beeswax, (3) paraffine. As the beeswax of commerce is largely made up of paraffine, however, there is not a great deal of preference between these two.

A compound-wound multipolar generator, running in parallel with others of the same type, drops its voltage continuously after being thrown in circuit, until it has to be cut out; what is the probable cause? W. C. H.

The shunt winding overheats enormously, increasing its resistance as its temperature increases and cutting down the field excitation.

What is the substance used for the glower in a Nernst lamp? (2). What literature is there on the subject of Nernst lamps? M. L. C.

The glower is made up of refractory oxides, such as thorium, yttrium, zirconium, magnesium, etc. Experiments have been made with various combinations of these oxides. (2). There are no books on the subject; the only literature consists of articles which have appeared in the technical press from time to time.

Can I run a series-wound 5-h.p. motor continuously on a 110-volt circuit, throwing the load on and off by means of a clutch? (2). How can I keep the machine down to half speed when it is not loaded? H. J.

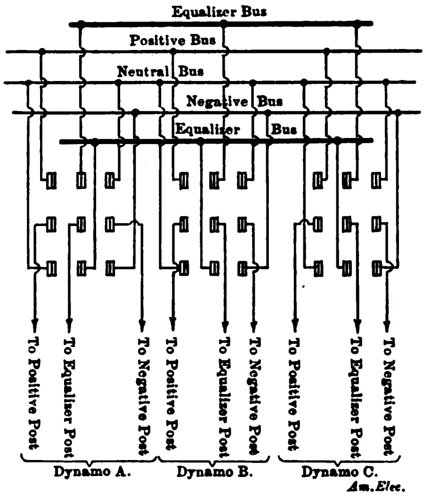
No; unless the machine is provided with a shunt winding it will run away when the load is removed. (2). It is not practicable to cut the speed down efficiently to half the normal, and there is nothing to be gained by doing so when the motor is not loaded.

Does a series-wound motor race when the load is removed, and if so, why? (2). What size of generator would be required to supply five motors of 10 horse-power each? F. A. M.

Yes, if the machine is on a constant-potential circuit. When the load is removed the armature speed increases slightly, because most of the opposition to the torque is removed. This increase in speed increases the counter e.m.f. and reduces the current in the motor circuit. The reduction of the current weakens the field, and the motor speeds up still more, and this action is cumulative. (2). 50 kilowatts.

How can I connect up three 125-volt direct-current generators to the switchboard of a three-wire system, so that any generator can be thrown on either side of the system? I. M. S.

Make the main switch of each machine a triple-pole double-throw switch instead of the ordinary single-throw switch, and connect the switches to the bus-bars as shown by the accompanying diagram. Thus, throwing any one of the switches upward connects its generator between the positive and neutral bus-bars and to the upper equalizer bus, and throwing the switch downward connects the machine between the neutral and negative bus-bars and to the lower equalizer bus.



For a three-wire direct-current system of moderate size, would not double-commutator generators, giving 110 volts at each commutator, be preferable to the employment of 110-volt generators on each side of the system? A. B. C.

No; such an arrangement could not be used satisfactorily because the voltage on one side of the neutral wire could not be regulated independently of that on the other side. The most advantageous method for a small-size three-wire system is to use generators connected to the two outer wires only, and to balance the two sides of the system by means of a motor balancer.

Can I charge a storage battery when it is sealed air-tight? (2.) How is the best paste for storage battery plates made? E. F. W.

It is inadvisable to attempt it as the pressure of the gas evolved is likely to damage the cell. (2). For the positive plate mix red lead with diluted sulphuric acid into a paste, using only enough liquid to make the red lead workable and not enough to make the paste appear moist. For the negative plate make a paste of litharge and dilute sulphuric acid. The pastes should be mixed with wooden spatulas in glass or earthenware vessels. The diluted acid consists of one part concentrated sulphuric acid and nine parts of distilled water, by weight. Pour the acid into the water in mixing, not the water into the acid.

Will a storage cell having its plates connected in series give a higher e.m.f. than with the plates connected in parallel in the usual way? (2). Can a Leyden jar be charged from an induction coil? G. I. D.

No; such an arrangement would only give the same e.m.f. as a single pair of plates, assuming that the intermediate plates would stand the short-circuit imposed upon them. As a matter of fact, however, the plates would buckle and destroy the battery. (2). A Leyden jar can be used as a condenser in connection with an induction coil, in which case it will be alternately charged and discharged. The only way to make a Leyden jar or other condenser retain a charge for an appreciable length of time is to deliver the charge from a static or friction machine.

How can I calculate the inductance of a coil in henrys? H. C.

It is extremely difficult to calculate the inductance of a winding. The formula for inductance is:

$$L = \frac{2257\ t^2\ A\ \mu}{100{,}000{,}000\ l}.$$

In this formula *t* is the number of turns in the coil, *A* is the cross-sectional area of the path followed by the magnetic flux, μ is the permeability of the medium through which the flux passes, and *l* is the length of the path. If the coil were wound on an iron ring so that the material would be the same throughout the magnetic circuit then it would be comparatively easy to figure the inductance, but the magnetic path traversed by lines of force in most pieces of electrical apparatus usually consists partly of air and partly of magnetic material, the latter being magnetized to different degrees at different parts of the magnetic circuit, so that the permeability varies at different parts of the circuit. The inductance of a coil without any iron in its magnetic circuit may be found by using the above formula and omitting the factor, μ. In this case *l* would represent the length of the coil. The most reliable way to ascertain the inductance of a coil is to apply a sufficient alternating e.m.f. to its terminals to force through the normal current which the coil is to carry; call this e.m.f. *E* and the current *C*. Representing the resistance of the coil by *R* and the frequency of the alternating current by *n*, the inductance is equal to

$$\frac{\sqrt{\left(\frac{E}{C}\right)^2 - R}}{2\pi n} \sim L.$$

THE COMPARATIVE TESTING OF FAN MOTORS.

BY A. R. EVEREST.

In the June number of the American Electrician Mr. S. D. Gilbert describes a method of comparing the output of different fan motors which consists in measuring the total pressure produced on a screen by the fan, which is so placed as to blow against it. It is not evident that this method gives a true comparison of the work of the motors considered from the standpoint of the customer. The degree of satisfaction which can be obtained from a fan motor is measured, not by the pressure it can produce upon a wall raised in front of it, but by the amount of air which it will circulate in a room, and by the way in which the stream of air is dispersed. A motor which will deliver the air in a widely spreading cone is more desirable for ventilating purposes than one which delivers a strong blast in a concentrated beam.

Some manufacturers, appreciating this feature, produce motors which distribute the air over a wide area. It is evident that if two motors, both giving an equal number of cubic feet per minute but differing in distribution in the way referred to, were compared by the method described by Mr. Gilbert, the motor which is actually more desirable would be made to appear the poorer, since the more divergent blast strikes the screen at an angle and its full pressure is not exerted on the screen.

The air output from a fan motor should be measured by means of an anemometer, a small instrument containing a fan with light aluminum blades and mounted in frictionless bearings. When placed in a current of air the velocity of the air is indicated in feet per minute on a meter dial attached to the instrument. At a convenient distance (say 3 ft.) in front of the fan a light stick is supported horizontally, parallel to the face of the fan. A mark is made at a point opposite the center of the fan, and along the stick are drilled a series of holes 1 in. apart, to fit the supporting leg of the anemometer. The stick is supported at such a height as to bring the center of the anemometer level with the center of the fan motor. The blast is thus divided into a series of imaginary concentric rings, each 1 in. wide, and the air velocity is measured for each ring. Multiplying this by the area in square feet of the ring, or band, gives the cubic feet of air per minute for that band. Measurements are made at intervals of 1 in. along the stick, from the center or axial line to a point where no further movement of the air can be detected, and each measurement is multiplied by the area in square feet of the band to which it corresponds. The sum of all these results gives the total output in cubic feet per minute, which is the information really desired.

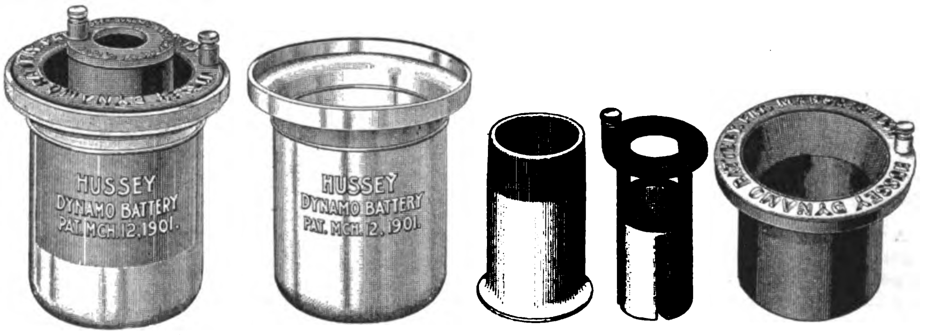
It is generally preferable to take readings on both sides of the axis and average the two readings for each radius. Of two motors, both giving equal air output, that one which gives the largest portion of its air at a greater distance from the center is the more desirable motor, other things being equal.

A fan motor will give its largest output when mounted in the center of a room of approximately cubical dimensions. If another test is made in a narrow room, much obstructed by furniture, it will be found that the measured output is reduced. (Hence it becomes necessary to carefully maintain uniform conditions when comparing different makes of motors). If another measurement is made after placing the motor a few feet distant from a wall or screen, it will be found that the air output is now enormously reduced due to the back pressure created. The actual amount of reduction will vary with different fans, and since this is not the condition intended either by the designer or the customer, it is evident that a method of selection which judges motors by their performance under this condition is not the proper method for a comparative test.

◆

BISULPHATE OF MERCURY PRIMARY BATTERY.

With the advent of summer and the electric fan there naturally arises a demand for some reliable source of current with which to operate the fan motor, especially where electric circuits are not available. The storage battery is an admirable substitute; but facilities for recharging are necessary, and all too frequently do not exist. Recourse must then be had to some sort of primary battery. One of the most interesting types of this character is that which has recently been put on the market by the Hussey Dynamo Battery Company of New York. This cell has been named the "Hussey dynamo battery" on account of its large amperage and the general ease with which it can be handled. The excitant is bisulphate of mercury and the battery is built up in the tubular form indicated by the accompanying illustrations, which show the outer special containing jar and the cell complete. The jar may be of glass or rubber, and the elements, zinc and carbon, are made in annular form as shown, thus presenting a very large surface to the action of the electrolyte. The upper connectors of metal parts shown resting on the rim of the flanged battery carbon are of aluminum, which is not attacked by the mercury bisulphate. The lower end of the carbon is provided with an inner flange, thus enabling it to hold the porous cup, which has a flange extending outwardly and resting on the carbon flange, without, however, constituting a liquid-tight joint. In the porous cup is suspended the circular zinc, made in two portions, an upper and a lower ring connected by bars or straps. When the battery is assembled the porous cup is inserted into the cylindrical carbon so as to rest on the internal flange. The annular space between the carbon and the porous cup is then filled with bisulphate of mercury to the flaring portion of the carbon which is shown clearly in Fig. 5. When this has been done the carbon and cup are inserted into the glass jar, and the latter is filled through the hole in the top of the zinc with water to within 1 in. of the top.



FIGS. 1 TO 5.—HUSSEY DYNAMO BATTERY, COMPLETE AND IN PARTS.

In operation, the mercury bisulphate is decomposed so as to set free sulphuric acid, while the oxygen given off unites with the nascent hydrogen liberated from the zinc, forming water. The metallic mercury being precipitated and passing between the carbon and the porous cylinder, collects on the floor of the containing jar. Salts of zinc are formed also, and these are gradually dissolved in the exciting solution. The renewal of the oxidizing bisulphate of mercury is accomplished by inserting another supply through the flare or wide funnel-shaped opening in the carbon, and thus a great advantage is secured in being able to renew or recharge the battery without dismantling it or even suspending work.

When the exciting solution has become unduly saturated with the salts of the zinc the nozzle of a syringe can be inserted into the cup and the saturated solution taken off. The metallic mercury which has collected at the bottom of the jar can also be removed from time to time, and having a value may be worth while collecting. Water is then supplied to the porous cup, or such other renewal of the solution may be made as it is the practice of the user to employ.

With two of these batteries in series any fairly well constructed fan motor taking from 10 to 15 watts may be operated satisfactorily. When the battery is not in use it is said to have very little local action and to maintain its internal resistance and e.m.f. substantially unimpaired. The battery is 8 ins. high by 7 ins. across the top of the flange, and has an e.m.f. of 1½ volts.

FAN MOTOR EFFICIENCY.

The accompanying curves give the results of actual tests made by the Emerson Electric Manufacturing Company of St. Louis on fan motors, and show the comparative efficiency of alternating-current desk fans, compiled from velocity of the air thrown and the current consumed. The manufacturer claims that the tests were very carefully made, and that extreme care was taken to have the conditions uniform for each of the five types tested. All of the motors were provided with 12-in. fans except motor *C*, which had a 13-in. fan, and the terminal pressure was 113 volts. The consumption in watts was said to be as follows: Emerson Special, 43, Emerson Standard, 50, Fan A 64, Fan B 100, and Fan C 200. Curves in Fig. 1 show the velocity of the air delivered by the various fans when operated under uniform conditions and consuming the amount of current specified. The curves shown by Fig. 2 were made from the data given by the curves in Fig. 1 and show the relative amount of air that should be thrown by the fans if each fan were consuming the same amount of current. All tests were made with guards on the fans.

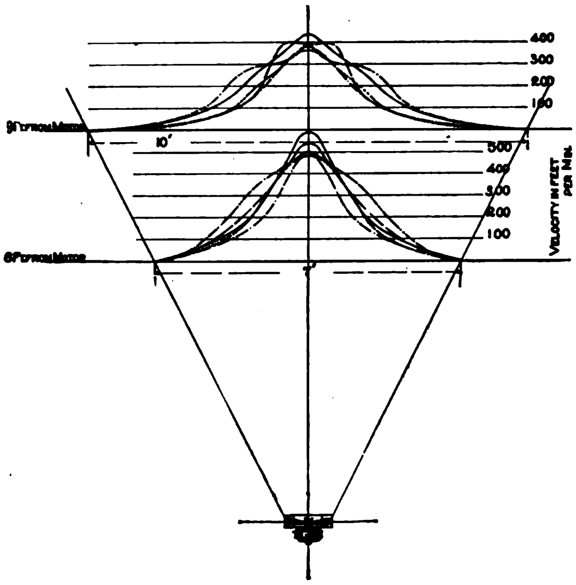


FIG. 1.

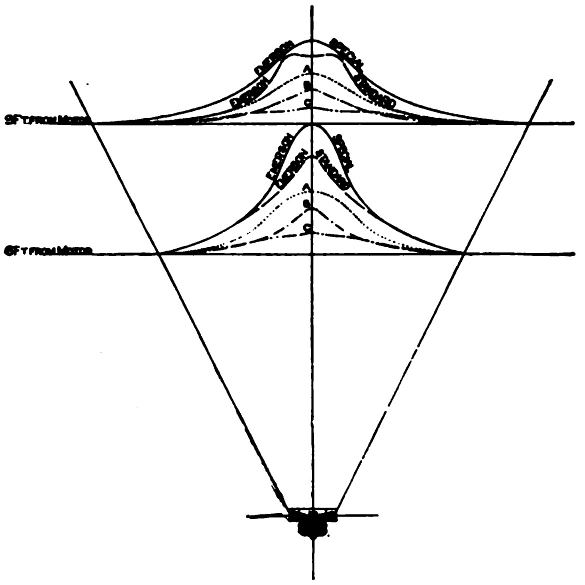


FIG. 2.

AN IMPORTANT INDUSTRIAL DEAL.

It is officially announced that the General Electric Company has purchased the German and French shareholdings in the British Thomson-Houston Company, Ltd., of London, England, thereby giving the American company the controlling interest. Messrs. C. A. Coffin, president; Eugene Griffin, first vice-president, and W. J. Clark, general manager of the Foreign Department, will be members of the British Thomson-Houston board, and the closest co-operation will exist between this company and the General Electric Company. The British Thomson-Houston Company was originally a licensee of the Thomson-Houston Company of America, and the latter, as is well known, was combined with the old Edison Company to form the General Electric Company some years ago. The British Thomson-Houston Company has been operating under patents of the General Electric Company, but as an independent concern.

◆

TWENTIETH CENTURY ENGINE.

The accompanying engravings illustrate the new Twentieth Century Corliss engine which has just been brought out by the Lane & Bodley Company, St. Louis, Mo. The photographs here reproduced show the first engine of the new line, which is exhibited at the Pan-American Exposition.

The loss of patterns by fire recently made it necessary to complete a new line of Corliss engine patterns, and the company took this opportunity to design an engine embodying all of the improvements which their fifty years in the steam-engine business showed them to be of value. The requirements which they have designed the engine to meet are that it shall stand 150 lbs. steam pressure, that the ports shall have ample area for a piston speed of 750 ft. a minute, and that in case of necessity the valve gear and other parts of the engine shall work quietly and easily at 125 r.p.m.

The engine frame is of the heavy-duty type, having a bearing on the foundation throughout the full length and width. The main bearing is made in four sections; the wedges, being forced downward from the top, permit of the removal of the quarter boxes after removing the cap. The bottom shell can be removed by revolving it on the shaft, after raising the shaft less than half an inch, thus obviating the necessity of removing the eccentrics or governor pulley in order to withdraw the wedges from the side. The outer bearing is of the floor-stand type, and the bearing proper is made in four sections, like the main bearing. The cross-head shoes are removable without disconnecting the connecting rod. The connecting rod is of the usual solid-end type, with babbitted crank-pin boxes and bronze cross-head pin boxes. The cylinder has round corners with sheet-steel lagging and polished angle corners.

In the valve gear a considerable change has been made. The steam and exhaust valves are operated each by a separate eccentric, the eccentric rods connecting to rocker arms; from the rocker arms two parallel rods are attached directly to the steam and exhaust bell cranks. The valves are double ported and of small diameter. The lever which operates the steam valve is keyed onto the valve stem between the front of the bonnet and the stuffing box.

The dash-pot rod is attached to the plunger by a ball joint, and the dash pots are located close up under the steam bon-

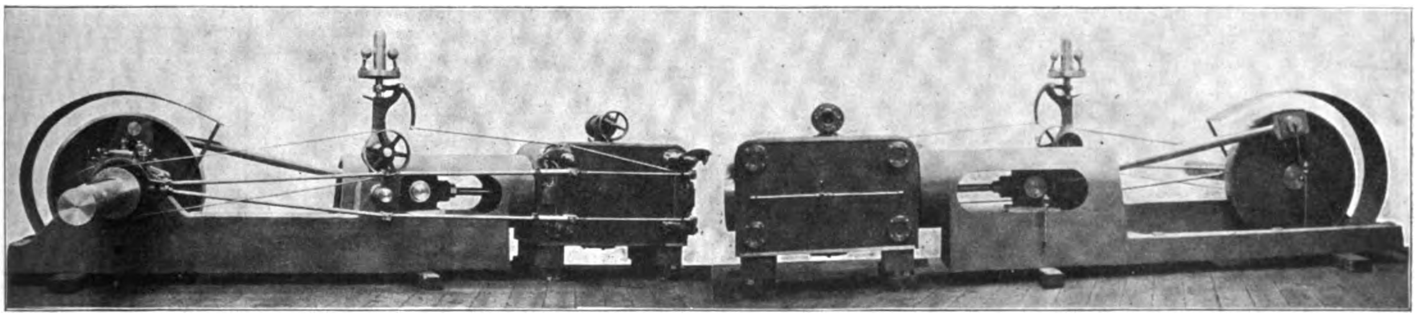


FIG. 1.—"TWENTIETH CENTURY" CORLISS ENGINE.—FIG. 2.

nets, making the rods short and light, and placing the dash pots at a convenient height for inspection and adjustment, as well as removing them from the dust and dirt. The lubrication of the plunger is effected by applying oil in a groove at the top of the cylinder. The tendency of the vacuum is to draw the oil into the cylinder instead of its being blown out by the air of the compression chamber, as was the case with the old type of engine.

The governor is of the company's well-known Hartnell type, running at 200 r.p.m., this speed making it very sensitive to slight variations in load.

SOME OF THE EXHIBITS AT THE PAN-AMERICAN EXPOSITION

Although the electrical, machinery and transportation exhibits are by no means complete at the time of writing, there is even now an ample array of apparatus to keep the interested visitor constantly busy for at least a week or ten days. We particularly regret that at the time of preparing this issue for the press the condition of the large and varied exhibits of the Westinghouse and the Stanley companies is such as to preclude any attempt at description. These will receive attention, however, in a future issue. Even in the unfinished state of the exhibits, considered collectively, an extended mention of the apparatus already in position is prohibited by space limitations.

THE KELLOGG SWITCHBOARD & SUPPLY COMPANY, of Chicago, has a magnificent display of telephones and switchboard apparatus in keeping with its large facilities and engineering corps. A multiple board with a capacity of 3000 lines and with 1080 lines wired in is in regular operation in the back part of the booth. This board is complete as it would be in a regular exchange. In the basement under the board are the cross-connection boards, heat coils, relays for lamp signals, power board, storage batteries and everything necessary for an exchange equipment. The relays are in the basement on this board, but a few sections of another type of multiple board are to be installed which will have the relays on the back of the board. Two 20-volt chloride storage batteries are used for the talking and signaling work on the operative board. Two motor-generators are provided for ringing, one of which runs on the 110-volt supply circuit and the other on the 20-volt battery. All this part of the exhibit is in operation. Turning to the display part, the most prominent and interesting thing is a section of a 12,000-line multiple board. Accommodation for this enormous number of lines is secured by putting the multiple jacks only ⅜ in. between centers. A half-dozen small switchboards are shown. These are of various types, one of which is a 20-drop wall board without keys. All the switching operations are done by plugs. This board is as simple as a switchboard can be made, though of course not as rapid as more elaborate boards. A large number of telephone instruments are shown, all of which have the company's new long-distance transmitter, which is of very substantial construction and is sent out sealed with a guarantee for several years. One instrument is shown for use with the Kellogg two-division board. This board is intended to be used in an exchange of over 12,000 lines, that being the present limit of multiple working. The subscriber on a two-division board can call either division by pressing A or B button, but at the same time has only one line to his instrument. The new heat coil of this company is used for the first time on the operating board. This heat coil is of graphite with a low melting alloy in one terminal. This magnificent exhibit was installed by Geo, L. Burlingame and is in charge of Paul W. Bossart, assisted by Ray H. Manson.

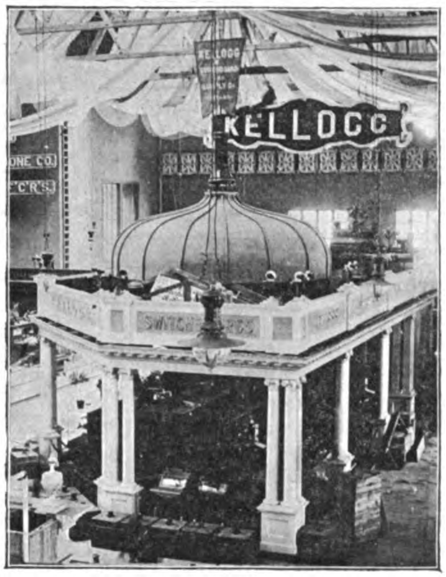


FIG. 1.—KELLOGG EXHIBIT.

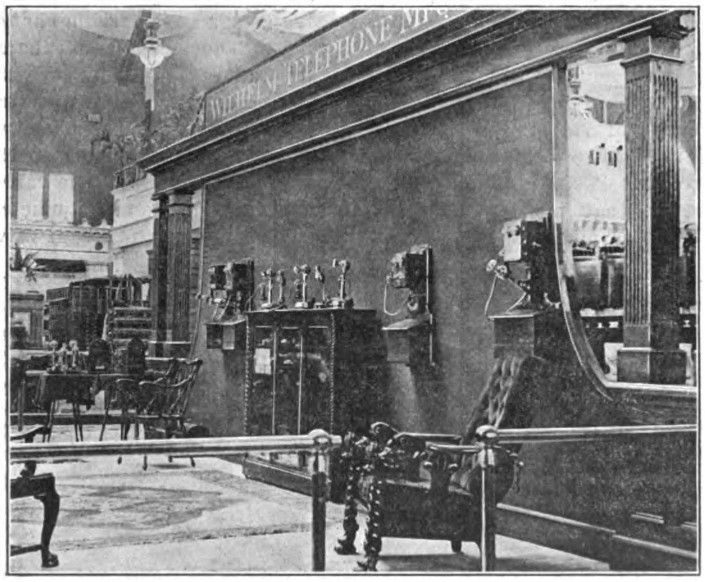


FIG. 2.—WILHELM EXHIBIT.

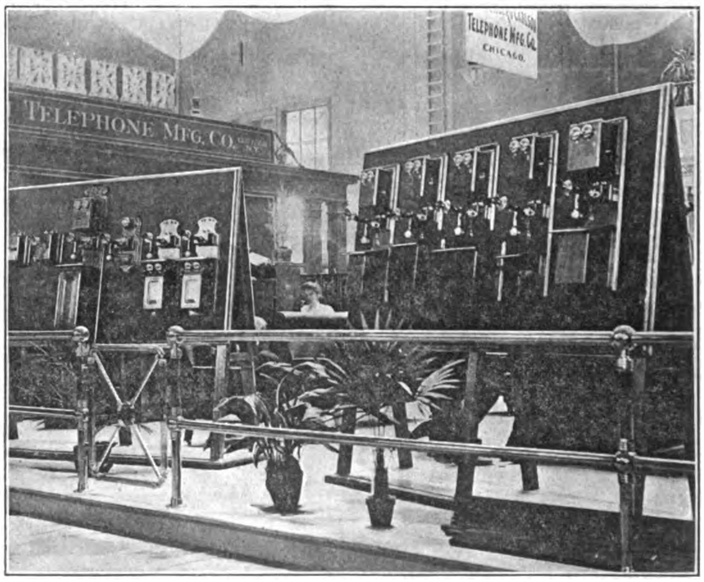


FIG. 3.—STROMBERG-CARLSON EXHIBIT.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, of Chicago, was on the ground early with an exchange in operation for the benefit of the Exposition officers, etc. The service is free and is very efficient. A 100-drop, visual signal, central-energy switchboard is at the present writing connected on this service, though the service is soon to be transferred to a 100-line lamp signal board. A sample section of a 3600-line board and a 100-line visual signal board are in place, and a 40-volt 165-ampere-hour storage battery, with charging motor-generator and power board, is furnishing current. Over 28 styles of central-energy and magneto subscribers' instruments are shown on sample boards. The most interesting part of the exhibit is being installed. It is a section of a 9600-line multiple board. The jacks are on ⅜-in. centers. This is the style of board that is being built for the new Detroit exchange and is of special interest because of its large capacity. Paul M. Krahmer, traveling engineer of the company, has charge of the installation.

THE GENERAL ELECTRIC COMPANY has a comprehensive exhibit in the northwest corner of the Electricity Building, the principal feature of which is a 5000-h.p. transformer plant that serves to transform all of the current used for lighting the Exposition buildings and grounds. This plant comprises 18 transformers of 250 kilowatts each, giving a total working capacity of 4500 kilowatts. Another feature of the exhibit which is particularly interesting is a complete installation of G. E. series alternating-current enclosed-arc lamps, by means of which the interior of Electricity Building is lighted. There are two lighting circuits, both supplied with current through one standard 75-light constant-current (tub) transformer, the transformer taking current from a 100-kw. revolving-field constant-potential alternator belt-driven by a synchronous motor which is supplied with current from the main transformer plant just mentioned. Aside from exhibition considerations, the reason for supplying current to the constant-current transformer from a local alternator, instead of from the main transformer plant, is that the frequency of the main current is 25 cycles, which is too low for satisfactory arc lighting. This installation is a complete one from a central-station point of view, the plant including standard switchboard panels, a C.R. regulator in the primary circuit of the "tub" transformer, and the compensated-field feature applied to the alternator.

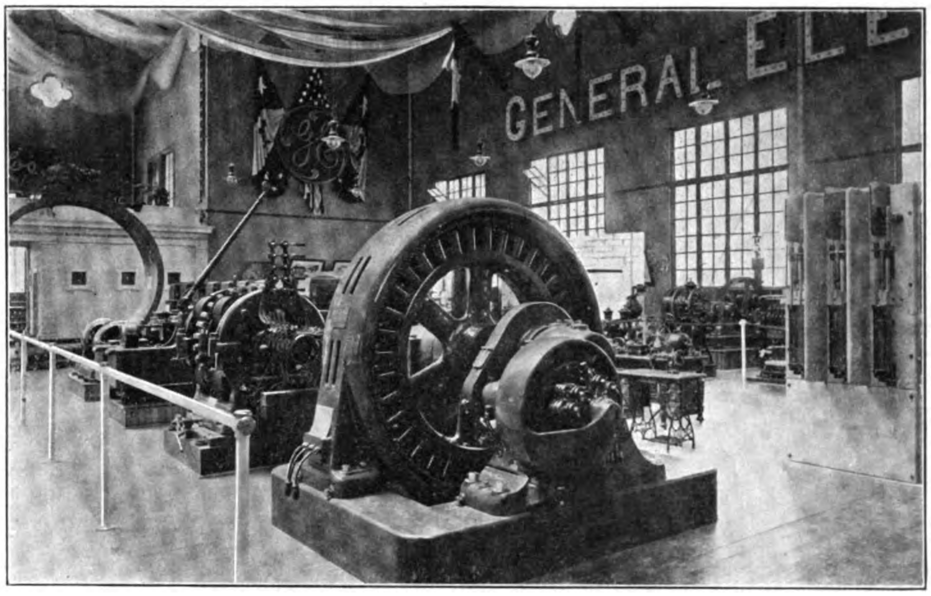
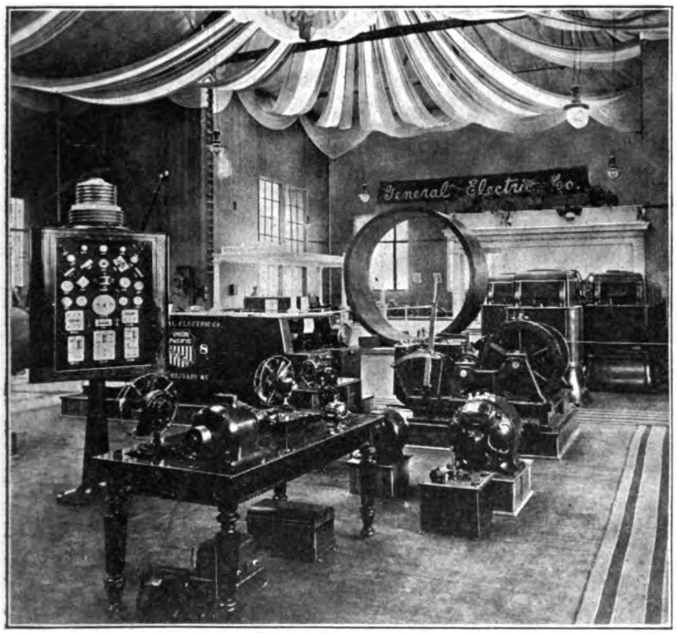


FIG. 4.—PART OF THE GENERAL ELECTRIC EXHIBIT.



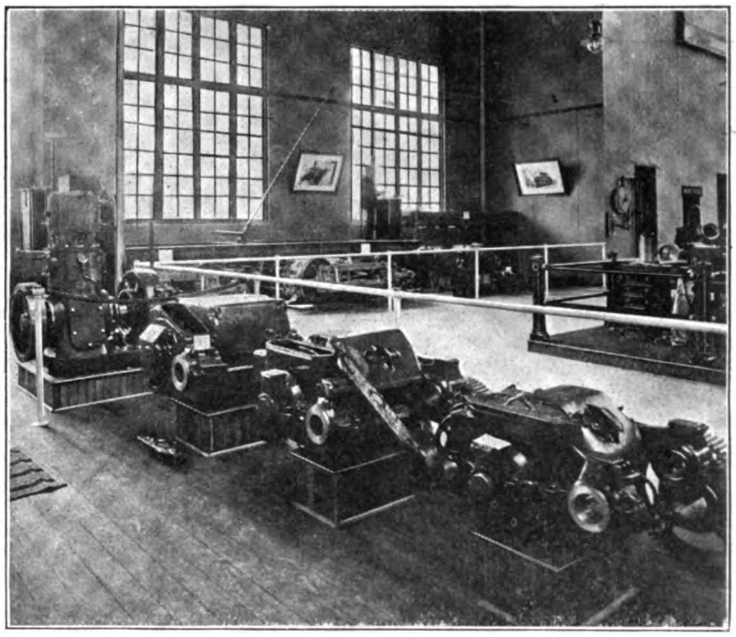


FIG. 5.—OTHER VIEWS OF THE GENERAL ELECTRIC EXHIBIT —FIG. 6.

The exhibit also includes a small constant-current transformer enclosed in a glass case and connected to a few arc lamps and series incandescent lamps, so that visitors have an opportunity to view the actual working of the moving parts of the transformers. The series incandescent street-lighting system of the company is also shown in actual operation, consisting of circuits of series incandescent lamps supplied with current through a small reactive coil. These lamps may be cut in and out by means of small switches, so that the regulating feature of the system can be practically illustrated. A beautiful type of modern apparatus is also shown in the shape of a 200-kw. compensated-field alternator and exciter; Fig. 4 herewith shows this machine in the foreground. It is of the revolving-field type, with 36 field-magnet poles. The exciter, as the illustration shows, is mounted on the alternator base and driven by gearing enclosed in a gear case somewhat similar to that used on street-railway equipments. This gear transmission is used because it is necessary that the speed of the exciter shall have a definite ratio to the speed of the alternator, and that this ratio shall be rigidly maintained. The exciter itself is quite an interesting little machine. It has 12 poles and is provided with a Dobrowolsky pole-ring or bushing, consisting of a wrought-iron ring about ¼ in. thick, which bridges all of the poles.

The company's railway exhibit is very complete, as may be inferred from an inspection of Fig. 6. There are exhibited three sizes of car motors, ranging from the standard size employed for ordinary street-railway work up to the size adapted for heavy interurban and elevated service. There are also actual working examples of the company's train-control system, sectional third-rail system, and electric brake system. These are shown in the background of Fig. 6. The contacts used on the third-rail system are mounted on small wheels, so that they may be moved along the rails for the various conditions of operating shown without having to move the car truck.

THE EUREKA TEMPERED COPPER WORKS, of North East, Pa., has a neat little space in which are displayed the numerous types of Eureka rail bonds and tempered copper drop-forged commutator segments, as well as a column of complete commutators.

THE BOSSERT ELECTRIC CONSTRUCTION COMPANY, of Utica, N. Y., has a display board which is wired as a switchboard with four panels. The two center panels are white marble, on which are mounted the regular adjustable-contact knife switches this company makes. The new Imperial switch which has just been put on the market is shown. The two outside panels are filled with different types of pressed-steel junction and wall boxes, and Erickson conduit insulators. The entrance to the space is through a gate made of an extra-long knife switch. This handsome display is in charge of M. F. Kittendrier.

THE O. C. WHITE COMPANY, of Worcester, Mass., which makes a very complete line of adjustable fixtures, has nearly forty varieties of its fixtures on exhibition, and they daily attract much attention both from members of the trade and from the general public. Fixtures will be found there suited to almost any conceivable location where an adjustable or movable incandescent lamp is required. The adjustable friction joints on these fixtures, which hold the arm at any angle to which it may be placed, are based on mechanical principles which Mr. White has applied to other classes of machinery, and upon which he has been awarded many medals at various expositions. E. G. Hunton explains the fixtures to callers and Messrs. O. C. White, Sr. and Jr., spend much time at the Exposition.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, has its space crowded with interesting material. Along the back is an end-cell switch of standard type. In front of this is a differentially-wound booster built for 800 amperes and giving 100 volts at full load. In connection with this booster is a switch for the shunt field, which can strengthen, weaken or reverse the shunt field as occasion may require to properly balance the charge and discharge of the battery. To prevent the booster from running away, should the circuit-breaker open on the motor driving it, the booster and motor circuit-breakers are mounted side by side and mechanically connected, so that when one opens the other will also. The regular "Chloride" cells are shown, and the new "Exide" pasted cell and all the details of construction of all the kinds of cells manufactured. A novelty in tanks is shown; it is an alloy tank to take the place of the lead-lined wooden tank that has been used so long. The largest cell shown is one which will discharge 2000 amperes for three hours. The company calls attention to the fact that its total output has now reached the point where the cells in use aggregate a capacity of 200,000 kilowatt-hours. Thomas Henning is in charge of the exhibit.

THE AMERICAN VITRIFIED CONDUIT COMPANY, of New York, is prominently located in the northeast corner of Electricity Building, with an interesting exhibit of a full line of its products (see Fig. 7). The company's leading article of manufacture is the multiple duct conduit, which is made in any number of ducts up to 16, in a single piece. This company furnished last year all of the conduit for the Subway Commission of Baltimore, Md., which amounted to over 5,000,000 ft.; it also furnished upward of 3,000,000 ft. to the Narragansett Electric Light Company, Providence, R. I.; the Boston (Mass.) Elevated Railway Company, the Massachusetts Telephone Company, Boston; Worcester (Mass.) Electric Light Company, and many other large users. For the present season the Rapid Transit Tunnel in New York, which requires 20,000,000 ft., the Manhattan Elevated R. R. Co., New York, requiring 2,000,000 ft., and the Metropolitan St. Ry. Co., New York, have also purchased their conduits from this company. Wardell E. Brown, who looks after the construction interests of the company and to whom great credit is due for the manner in which the exhibit is arranged, is in charge of the exhibit.

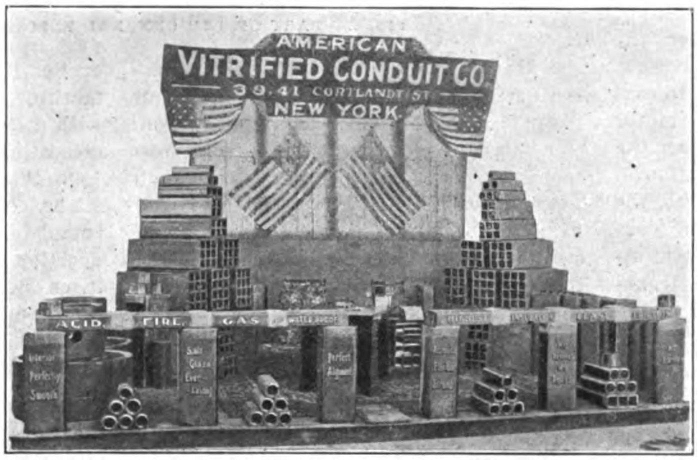


FIG. 7.—AN ATTRACTIVE EXHIBIT.

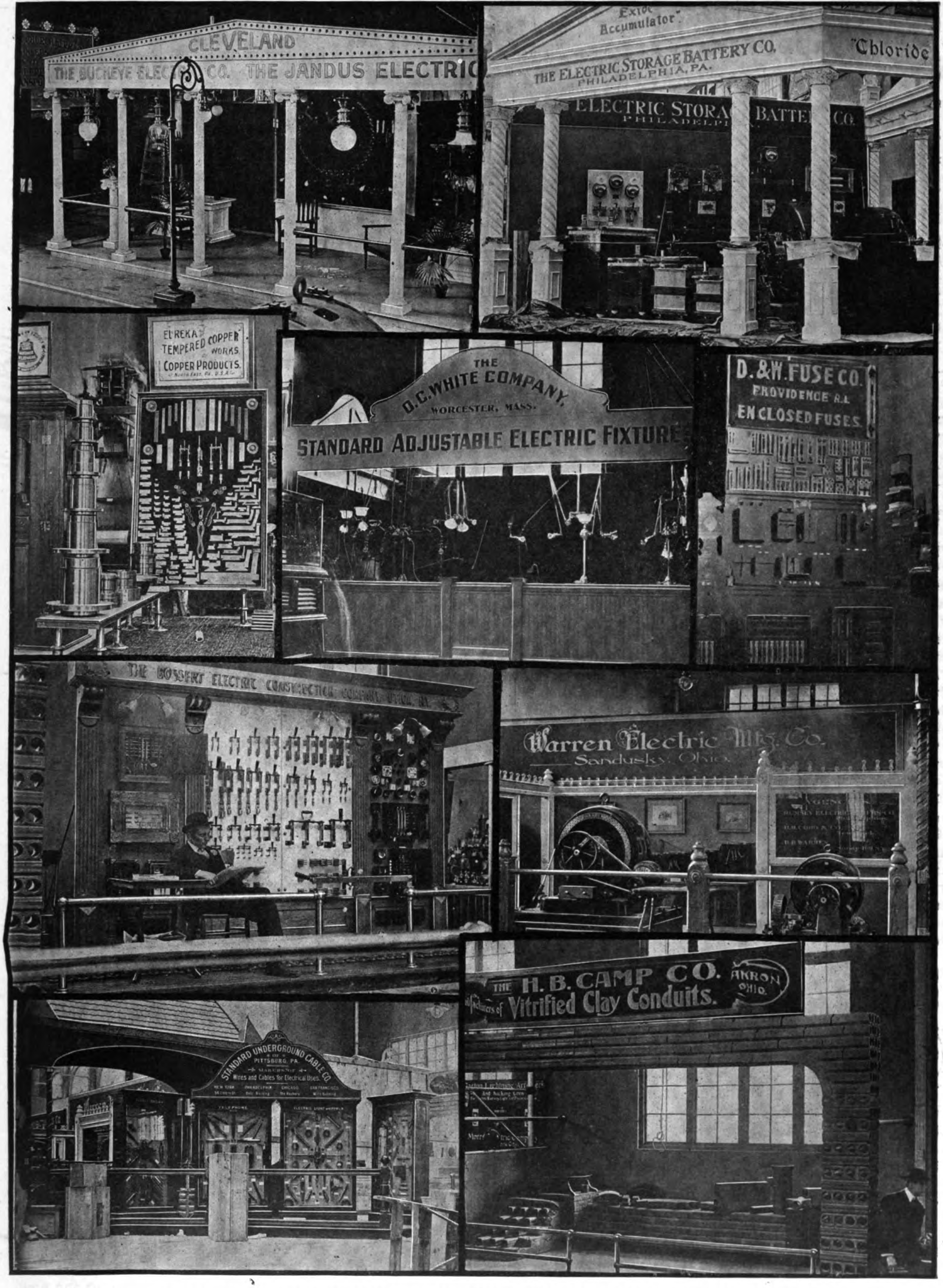
THE STANDARD UNDERGROUND CABLE COMPANY'S exhibit consists of four cases containing samples of all the rubber and paper-insulated cables manufactured by this company. One case is filled with wires, cables, terminal heads and accessories used in street railway work, including this company's patent junction boxes. A second case is devoted to telephone wires and cables, terminals and lightning arresters. In the third case are cables and accessories used in light and power work in distinction from street railway work. The fourth case contains telegraph and fire alarm material.

THE D. & W. FUSE COMPANY, of Providence, R. I., has an exhibit at the southeast corner of Electricity Building in charge of F. C. Perkins, its Buffalo agent. A number of iron-covered junction boxes for various services are shown, the largest being a 500-ampere, three-wire two-way cut-out. Of course, open combination cut-outs and service switches for smaller work are also shown.

THE WARREN ELECTRIC MANUFACTURING COMPANY, of Sandusky, Ohio, has an exhibit consisting of Warren inductor alternators and exciters. A 600-kw. machine, with exciter, built for 800 r.p.m. and 133 cycles occupies the middle of the space. It has an auxiliary field coil on the opposite side of the revolving inductor from the regular field coil and which can be moved in or out to vary the voltage of the machine. Alternators of 45 and 30 kilowatts are also shown. The latter is disassembled to show the construction, both the inductor and the coil being removed. Oil-insulated transformers in sizes from 600 to 8750 watts are in the exhibit and also some handsome photographs of the double-voltage direct-connected inductor alternator plant put in at Urbana, Ill. Harry S. Williams looks after the display.

THE H. B. CAMP COMPANY, of Akron, Ohio, has its well-known New York representative, A. L. Daniels, receiving visitors in a space the unique features of which are usually not appreciated until the visitor has taken some care to look around. The span between the two side pillars is made up of Camp's conduit laid with broken joints and with nothing but the cement and the strength of the conduit ducts to hold the span from coming down. This span is 17 ft. long and many will not believe that there are not iron supporting rods running through the conduit until Mr. Daniels induces them to mount a stepladder and see for themselves. Besides the span there are samples of underground construction and manholes. This company makes a split duct which can be put around a cable in case the regular duct gets broken by digging in the street, or in case the duct is broken away to repair a cable, and this is also shown as well as the standard straight and curved ducts.

THE ERICSSON TELEPHONE COMPANY, New York, has an interesting exhibit of a 50-line switchboard and several different types of instruments in the booth of W. Jac Marland, who has a collective exhibit. The company takes justifiable pride in the fact that the Ericsson telephone was awarded the first prize at the Paris Exposition in 1891, at Madrid in 1883, Vienna in 1884, Stockholm in 1886, Copenhagen in 1888, and Chicago in 1893. The Ericsson exhibit at the recent Paris Exposition was sent from the St. Petersburg factory of the company, and this was also awarded first prize.



A FEW OF THE EXHIBITS IN ELECTRICITY BUILDING, AT THE PAN-AMERICAN EXPOSITION.

New Apparatus and Appliances

UNIVERSAL GEAR-CUTTING AND MILLING ATTACHMENT FOR LATHES.

The accompanying engravings, Figs. 1 to 4, show a new attachment for lathes which is designed to take the place of gear-cutting and milling machines for many kinds of work. The bracket piece which contains the driving mechanism is attached to the cross-feed slide of the lathe in place of the regular tool block. The driving arbor which runs through this bracket piece transmits motion to the upright or cutter spindle by means of a pair of spiral gears which are encased for protection from dirt and chips. The driving arbor receives its motion from the head-stock lathe spindle through a train of three spur gears, one of which is screwed on to the nose of the lathe spindle and has a wide face, allowing a longitudinal travel of 3 ins. for the cutters. Any of the regular change gears furnished with the lathe may be used for the other two driving gears and by using different combinations a large number of speeds for the cutter may be secured. The intermediate gear is on an adjustable quadrant which swivels on the frame piece and allows a cross movement of the entire frame piece and slide rest, accommodating the cutters to the various sizes of work. The automatic longitudinal feed or the hand crank may be used to feed the cutter to the work.

The base of the swivel dividing head is securely clamped to the lathe bed by means of two bolts and a binder plate, and has cross and vertical feeds operated by a hand crank. The upright part swivels on the cross-feed slide, and the frame piece containing the spindle, indexing mechanism and the overhanging arm swivels on the vertical feed slide. Each slide has a finely graduated scale, thereby permitting of adjustments in the horizontal and vertical planes, and by means of the cross and vertical feeds, it becomes possible to make cuts of any desired angle.

For milling operations requiring a vise, the frame piece containing spindle and indexing device and overhanging arm, is removed and the vise arrangement is attached to the vertical slide. This may also be swiveled to any angle. In using this vise arrangement, the milling cutters may be driven by the head stock spindle. Chucks, centers, etc., may be used on both the head stock spindle of the lathe and the spindle of the swivel dividing head, as the taper holes and nose of both spindles are both of the same size. Gears may be cut as large as the swing of the lathe. A complete index is furnished and all numbers of teeth may be cut from 1 to 50 and nearly all numbers up to 360. Brown & Sharpe or any standard milling and gear cutters can be used.

Figs. 1 and 2 show the attachment arranged for cutting spur, bevel or miter gears, milling cutters, etc. Fig. 3 shows it arranged for cutting flutes in taps, reamers, etc., and Fig. 4 shows it arranged for slabbing and various milling operations requiring a vise.

This attachment was designed by the Seneca Falls Manufacturing Company, Seneca Falls, N. Y., for use on its well-known "Star" foot and power engine lathes from 9 ins. to 13 ins. swing.

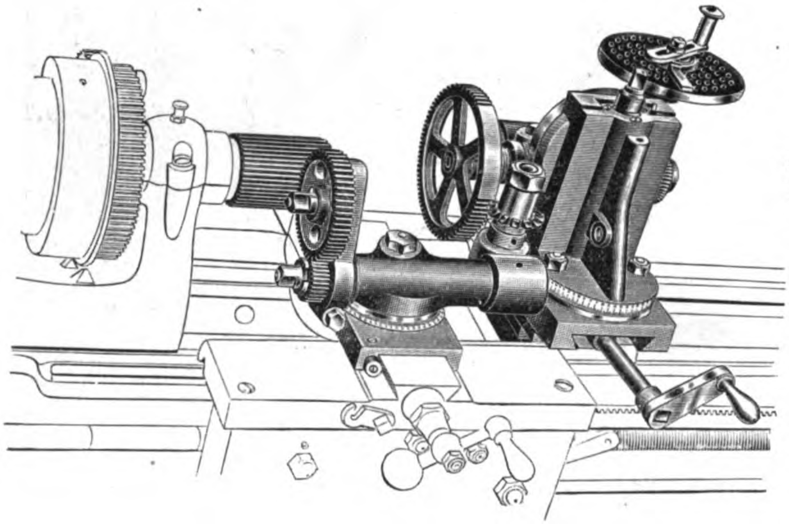


FIG. 1.—ARRANGEMENT FOR CUTTING SPUR, BEVEL AND MITER GEARS.

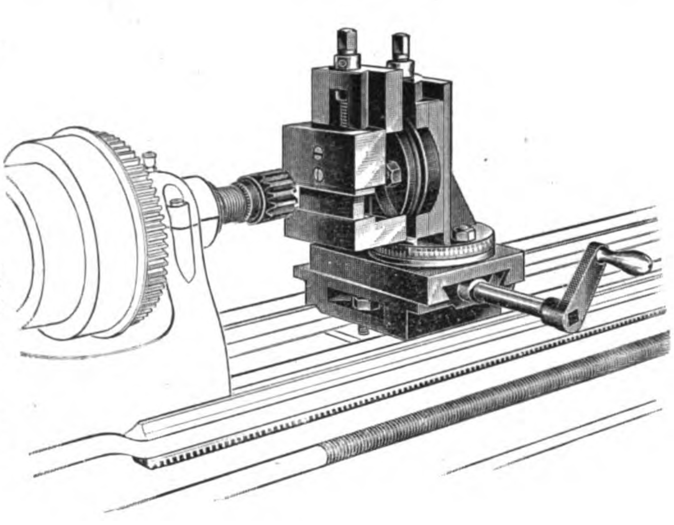


FIG. 4.—ARRANGEMENT FOR SLABBING.

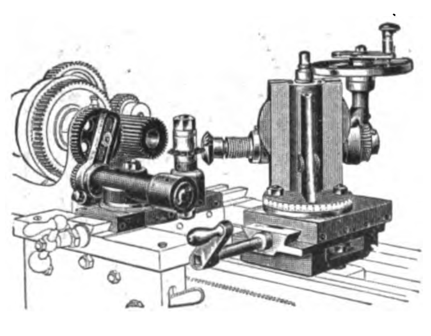


FIG. 2.—ARRANGEMENT FOR CUTTING SPURS.

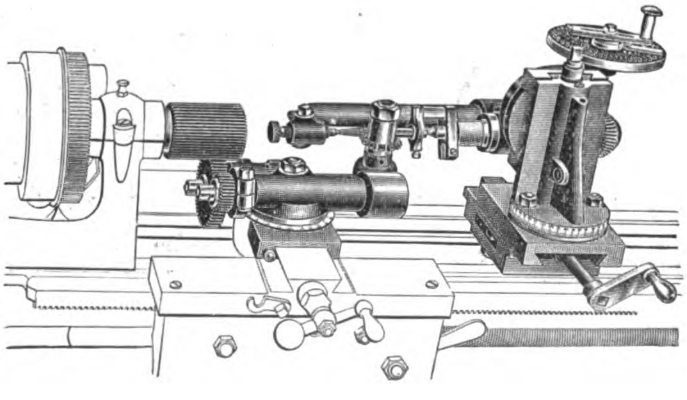
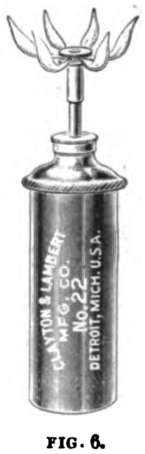


FIG. 3.—ARRANGEMENT FOR CUTTING FLUTES.

HANDY POCKET TORCHES.

Figs. 5 and 6 illustrate two torches of pocket size made by the Clayton & Lambert Manufacturing Company, of Detroit, Mich., which are of such a size as to be conveniently carried in one's pocket. Fig. 5 shows what is termed No. 21 Candle. It burns kerosene and produces a light many times stronger than a candle proper. A hook is provided by which it may be hung up, leaving both hands free. The No. 22 Candle illustrated by Fig. 6 burns either kerosene or gasoline, producing a light which will be found useful wherever a portable light is desired. It is 1¾ ins. in diameter and 6½ ins. high. The burner screws on the top. Both torches are made of heavy brass and nickeled.

FIG. 5.


CLAYTON & LAMBERT
MFG. CO.
No. 22
DETROIT, MICH. U.S.A.
FIG. 6.

CENTRAL TELEPHONE OUTFITS.

The accompanying illustrations show a few of the latest specialties of the Central Telephone & Electric Company of St. Louis. Fig. 7 shows a desk telephone made in the Bell style with sundry modifications and improvements. It includes a "20th Century" transmitter with the inductive coil placed in the base, which, with the stand, is of cast brass, finely nickeled. Platinum contacts are used on the gravity hook and the receiver cords and connecting cords are wrapped in silk. The receiver is furnished with an adjustable hard-rubber case; but a solid receiver is furnished if desired. Fig. 8 illustrates the Century Company's "Leader" type, which in efficiency, utility and general accessibility of all its parts, has many recommendations. As will be noted, the receiver and the generator handle are on the same level, and at the height of the arm of the average man, while the transmitter is correspondingly on the level of the mouth. The transmitter connections are made with four binding posts in such a simple manner that the part can be removed in an instant. The other working parts are, as will be observed, under the writing-desk lid, and are easily accessible. Two Columbia dry batteries complete the equipment. The set is furnished in either golden oak or walnut, and supplied in series generator or bar-bridging forms. Fig. 9 shows the "Competition" dry-battery type, with a different arrangement of parts, and of less costly woodwork and assembling, although the transmitter, receiver and generator are the same. It is built only in the golden-oak finish, and is supplied with two Columbia dry batteries. It can be had with series or bar bridging generators, as desired.

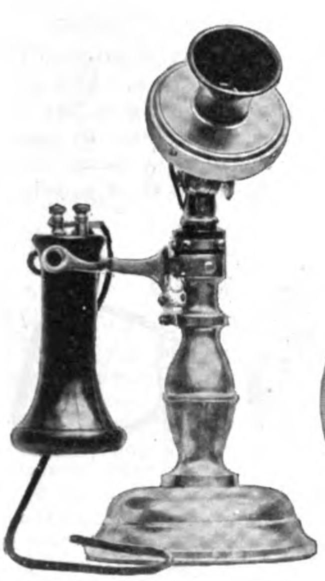


FIG. 7.—DESK TELEPHONE.

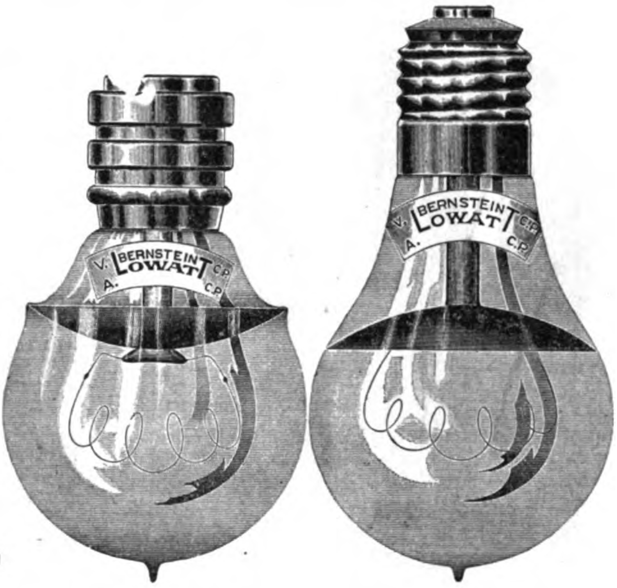


FIG. 10.—"LOWATT" REFLECTOR LAMPS.—FIG. 11.

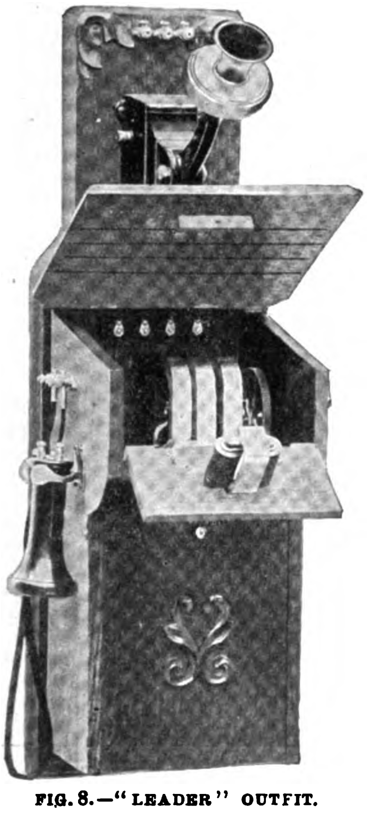


FIG. 8.—"LEADER" OUTFIT.

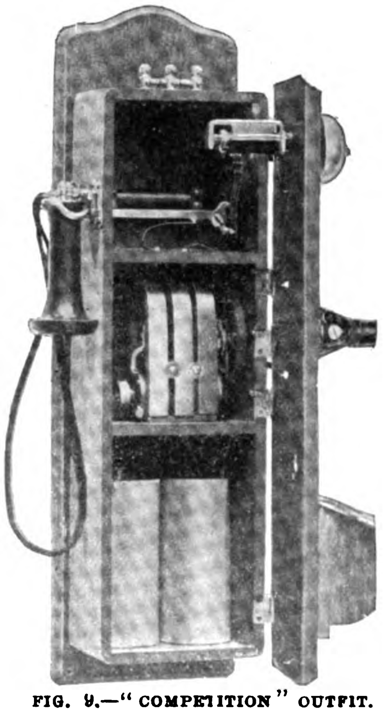


FIG. 9.—"COMPETITION" OUTFIT.

REFLECTOR INCANDESCENT LAMP.

Figs. 10 and 11 show the "Lowatt' incandescent lamp for which the Western Electrical Supply Company of St. Louis is agent. The lamp has a complete metal reflector entirely within the bulb and situated behind a multi-coiled carbon filament in such a manner as to utilize all of the reflecting surface. The lamps are made with three different types of reflector; a concave form concentrating the light, a convex form dispersing it, and a side reflector for show-window use. Unlike the lamps which are silvered on the outside, the reflector of the "Lowatt" covers the entire center, making a more efficient reflector. It is also claimed that the "Lowatt" lamp with a concave reflector shows a candle-power, measured through the tip, of from four to eight times its rated horizontal candle-power.

GALVANIC METAL ROD PACKING.

The accompanying engraving, Fig. 12, illustrates the application of a new metallic packing manufactured by the Galvanic Metal Paper Company, of Jersey City, N. J. This packing, which, as the illustration shows, is made in the form of a split ring, consists of alternate laminations of "galvanic metal" and absorbent non-metallic material, such as canvas, the latter being thoroughly impregnated with graphite and oil. In the course of manufacture these laminations are compressed under hydraulic pressure of 5,000 lbs. per square inch. "Galvanic metal" is an electrolytic production, consisting of chemically pure nickel and copper; a thin sheet of the metal shows nickel on one side and copper on the other. The packing is very flexible, and it is claimed that it does not cut or injure the rod in the slightest degree, and packs a stuffing box absolutely tight against steam (both saturated and superheated), air, water and ammonia. On account of the lubri-

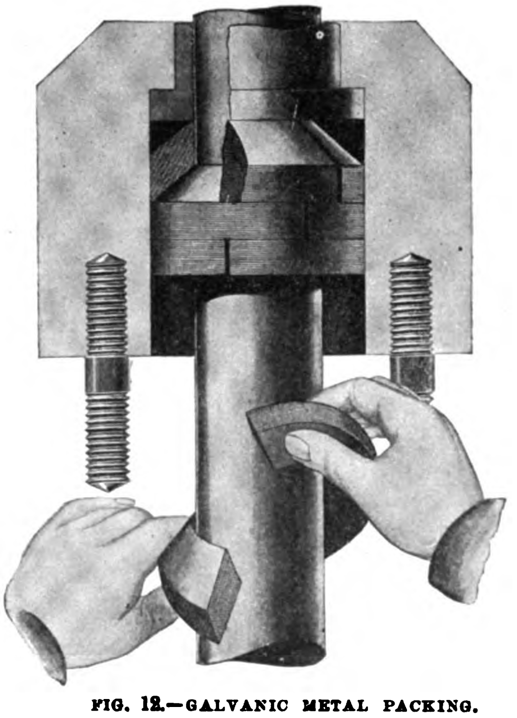


FIG. 12.—GALVANIC METAL PACKING.

cating layers in between the leaves of galvanic metal very little oil is required to maintain a rod in good condition. The rings are made up in conical or funnel form, so that the higher the pressure of steam, water, etc., the tighter does the packing close the stuffing box against the escape of the confined liquid or vapor. The company also makes dynamo brushes of this material, for which strong claims are made.

SURFACE CONDENSER AT THE PAN-AMERICAN EXPOSITION.

Fig. 13 herewith shows a "Wheeler-Admiralty" surface condenser complete with compound combined air and circulating pumps. The apparatus is set up in the court of the Machinery Building at the Pan-American Exposition, where it is used in connection with eight engines whose combined output aggregates 2000 horsepower. Both the air and the circulating pumps are operated by the same steam cylinder, all three pistons being attached to a common rod. The "Admiralty" type differs from the well-known Wheeler "Standard" condenser, in that it has single instead of double tubes. The shell is made of cast iron and has hand-holes conveniently placed for cleaning. The exhaust steam enters the condenser at the top and the condensed steam is drawn off from the bottom and delivered to the hot well by the air pump. The circulating water is pumped in at the bottom and after circulating through the tubes is discharged at the top of the condenser. The circulating water being hot and not having come in contact with the steam is consequently free from oil and may be used, as it frequently is, for washing or dyeing purposes, or for any other purpose requiring a plentiful supply of hot water.

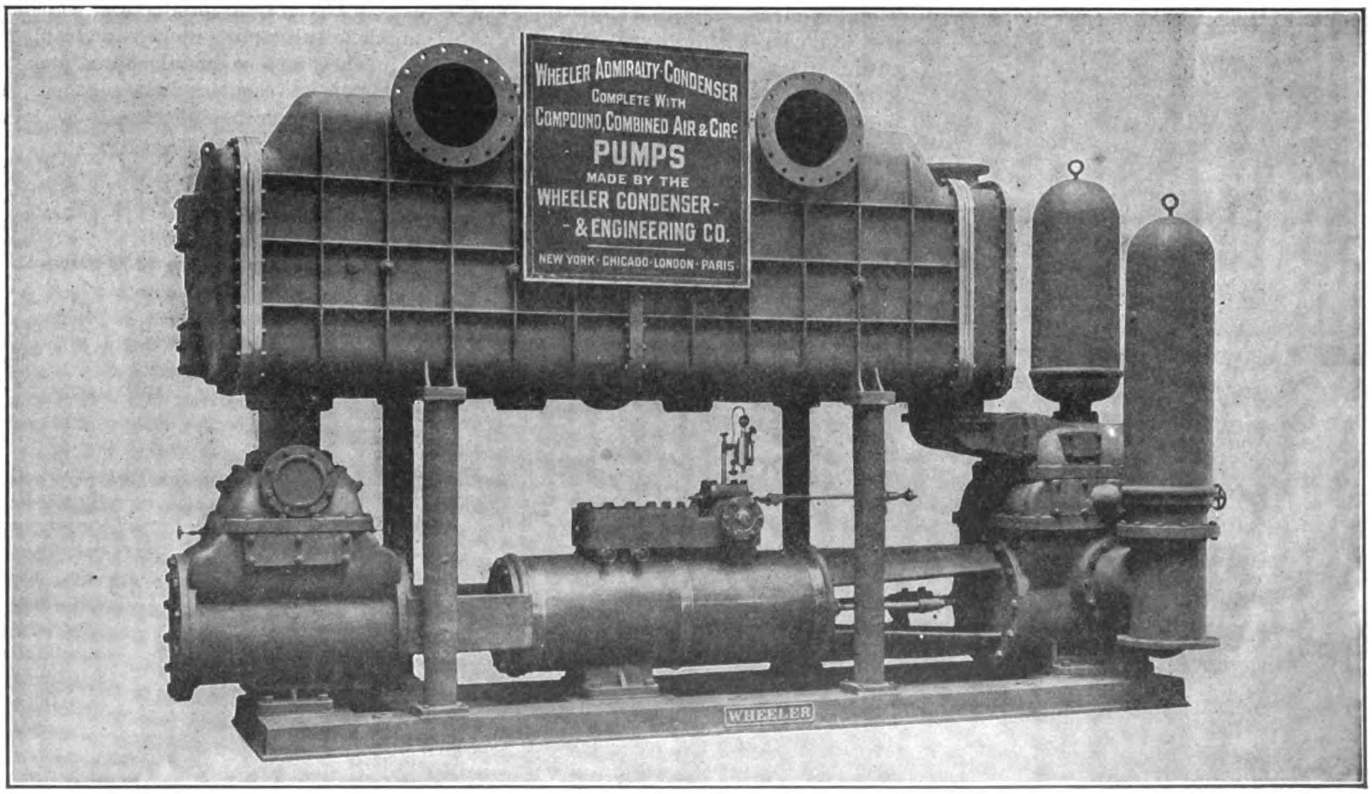

WHEELER ADMIRALTY CONDENSER
COMPLETE WITH
COMPOUND, COMBINED AIR & CIRC.
PUMPS
MADE BY THE
WHEELER CONDENSER-
-& ENGINEERING CO.
NEW YORK · CHICAGO · LONDON · PARIS
WHEELER

FIG. 13.—WHEELER CONDENSER IN OPERATION AT THE PAN-AMERICAN EXPOSITION.

FRANKLIN PORTABLE CRANE.

Fig. 14 herewith illustrates an extremely convenient form of jib crane that is built by the Franklin Portable Crane & Hoist Company, Franklin, Pa. It is of simple construction, consisting merely of a curved standard on which is mounted a chain-and-windlass hoist. The height of the crane over all is 6 ft. 4½ ins., and the height of hoist is 5 ft. 3 ins. The overhang is 2 ft. 4½ ins. and the lifting capacity is 2 tons. The handle by which the carriage is drawn about the floor is attached rigidly to the axle so that when the handle is thrown upward into the position shown, the axle is turned in its retaining sleeve, and allows the edge of the carriage to come down on the rims of the wheels, thereby preventing the machine from moving while the attendant is busy at the windlass.

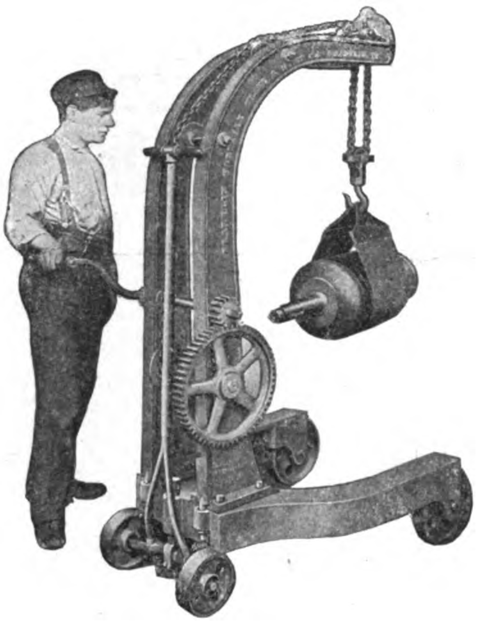


FIG. 14.—PORTABLE CRANE AND HOIST.

IGNITER FOR EXPLOSION ENGINES.

Fig. 15 illustrates a device patented by William Roche, of New York, which it is said does not have the tendency, like the ordinary gas-engine igniter, to spark where sparking should not occur. The body of the igniter is made of porcelain and is provided at the end fitting into the explosion chamber of the cylinder, with a central notch, forming two distinct lugs or projections. Extending from the lugs through the body are divergent passages for the reception of wires, the inner ends of which fit into tapering openings in the conducting caps which carry the platinum

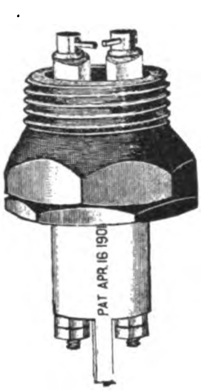


FIG. 15.

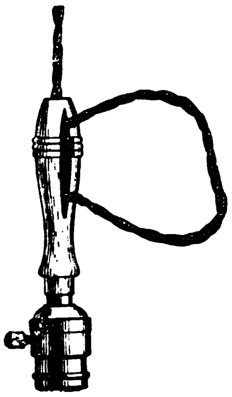


FIG. 16.

spark points, and the outer ends of which are threaded to receive nuts. The nuts are located in segmental recesses separated by an insulating partition, and serve to force the conductor caps against the lugs of the porcelain body. The divergent arrangement of the conductor brings their inner ends close to each other, precluding the danger of sparks within the body, and the insulating partition between the segmental recesses of the outer end prevents sparking between the adjacent edges of the nuts. The central notch, which forms the lugs of the inner end prevents the bridging of the space between the two caps by the electrical deposition of carbon on the lugs. When the porcelain of the igniter breaks it may be removed and a new piece set in without removing the receptacle.

A NEW CORD ADJUSTER

Fig. 16 on page 374 shows a new cord adjuster that is being marketed by George Webster, of Christiana, Pa. The adjuster consists of a slotted handle, attached directly to the lamp socket, as shown. It is claimed that it saves a cord as compared with other forms of cord adjuster, because this handle permits the utilization of all of the cord, requiring no extra cord for its operation. This adjuster holds the cord with absolute security, it is claimed.

Electric Light Convention Notes

WESTERN ELECTRIC COMPANY, Chicago, was represented by P. M. Fletcher and E. W. Rockafellow.

THE OKONITE COMPANY, New York, sent its general superintendent, George S. Manson, to the Convention.

W. J. WATSON and F. E. DONOHUE looked after the interests of the American Electrical Works of Providence.

PHILLIPS INSULATED WIRE COMPANY had H. C. Adams, Jr., on from Pawtucket to look after its interests at the Convention.

CHASE-SHAWMUT COMPANY, Boston, manufacturers of enclosed fuses, switches and switchboards, sent A. P. Moore to the Convention.

EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., had its interests ably taken care of at the Convention by H. L. Parker.

STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., sent W. B. Jackson, C. E. Bibber and W. L. Fairchild to the Convention.

B. C. KENYON, the popular manager of the Diehl Manufacturing Company, Elizabethport, N. J., was at the Convention in the interests of his company.

THE HELIOS-UPTON COMPANY had its storage-battery interests well taken care of by Frank H. Clark, of Chicago, the sales manager of this department.

AMERICAN VITRIFIED CONDUIT COMPANY, New York, showed some interesting samples of its product on the hotel piazza. A. S. Barnard represented the company.

ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, sent Charles Blizard, the general sales agent, to the convention. Mr. Blizard was assisted by A. Taylor.

THE CENTRAL ELECTRIC COMPANY, Chicago, was represented by President G. A. McKinlock, who was warmly greeted by many of his old friends and acquaintances.

PHOENIX GLASS COMPANY, New York, which has brought out so many handsome and unique products in the line of electrical glassware, was represented by A. H. Patterson.

A. P. ECKERT, whose extensive acquaintance in the electrical field is probably surpassed by no other member, represented the Safety Insulated Wire & Cable Company of New York.

COLUMBIA INCANDESCENT LAMP COMPANY, St. Louis, Mo., distributed attractive souvenirs of its product in the shape of badge buttons. A. C. Garrison represented the company.

THE HEINE SAFETY BOILER COMPANY of St. Louis, whose boilers are so well known in electric-lighting and power stations, was ably represented by P. H. Brangs, of the New York office.

NATIONAL CARBON COMPANY, Cleveland, placed its large carbon interests in good hands at the Convention when it sent N. C. Cotabish, general sales manager and also a director of the company.

S. B. CONDIT, JR., of Boston, was present in the interests of his company, which has just completed the installation of a double-front board for big new power-transmission work at Manchester, N. H.

CROUSE-HINDS ELECTRIC COMPANY, Syracuse. Many inquiries were made for Harry Crouse, but in his absence the company's interests were looked after by J. L. Hinds and F. M. Hawkins.

JAMES I. AYER, one of the well-known ex-presidents of the Association, was present in the interests of his company, the heating department of the Simplex Electrical Company of Cambridgeport, Mass.

A. H. PEASE, president of the Hart & Hegeman Company, came on from Hartford, and with his Western representative, George C. Searing, of Chicago, made many new friends for the Hart switches.

JOHN A. ROEBLING'S SONS COMPANY, Trenton, N. J., sent a large delegation, including H. L. Shippy, G. C. Bailey, M. P. Bowman, G. W. Swan, D. F. Irvins, H. C. De Camp and F. W. Harrington.

ARTHUR L. BOSLEY looked after the interests of the Electrical Material Company of Baltimore, which is putting out a line of switches which are reported to have given good satisfaction wherever used.

SHELBY ELECTRIC COMPANY, Shelby, Ohio, sent its New York representative, J. C. Wormley, to the Convention, where he explained to many interested visitors the merits of the Shelby incandescent lamp.

SAWYER-MAN ELECTRIC COMPANY had a number of representatives present from its various offices, including Frank S. Smith and G. A. Nellis, of Pittsburg, Henry Watts, from Buffalo, and C. S. Jennings, from New York.

MARTIN INSULL, of the General Incandescent Arc Light Company, New York, was unable to be present, but his brother, Joseph Insull, attended in the interests of the General Incandescent Lamp Company of Cleveland.

THE AMERICAN CIRCULAR LOOM COMPANY, Chelsea, Mass., had a large delegation present at the Convention in the persons of A. T. Clark, T. G. Grier, R. B. Corey, J. S. Wilson, H. B. Kirkland and J. R. Cole.

H. W. JOHNS MANUFACTURING COMPANY, New York, exhibited its well-known Noark switches in the lobby of the International. The company's interests were well taken care of by A. Hall Berry and Joseph Sachs.

McROY CLAY WORKS, New York, was ably represented by President J. T. McRoy and his Western representative, E. F. Kirkpatrick. The company has been enjoying an exceedingly large demand for its well-known conduits.

A. A. THRESHER, of the Thresher Electric Company, Dayton, Ohio, came in on the last day, but still found time to interest many of the attendants in the new vertical-shaft generators built by this company for water-wheel operation.

W. J. PHELPS came on in the interests of the Phelps Company, which has recently moved to Detroit, Michigan. Mr. Phelps reports a most gratifying demand for the "Hylo" incandescent lamp which his company is manufacturing.

THE SPRAGUE ELECTRIC COMPANY had its interior-conduit department well looked after by Alex. Henderson. The dynamo and motor interests were ably taken care of by H. G. Issertel, who has long been identified with the electrical industry.

G. F. PORTER, the Association's busy secretary, looked after the interests of the Brixey Kerite Cables, and found his manifold duties in connection with the meetings materially lightened by the efficient co-operation of Miss Billings, his assistant secretary.

THOMAS G. GRIER, who has been identified with the electrical interests of the West for many years, stopped off at the convention on his way from the East. Mr. Grier is the Western agent of the American Circular Loom Company, with offices in Chicago.

F. S. TERRY attended the Convention in the interests of Sunbeam lamps. It was rumored that his well-known abilities would soon be afforded a wider scope in the management of a contemplated consolidation of lamp companies with headquarters in Chicago.

BOSSERT ELECTRIC CONSTRUCTION COMPANY, Utica, N. Y. F. G. Schofield was present in his company's interest and was much gratified at the great interest shown by visitors in his handsome exhibit in the Electricity Building at the Pan-American.

PASS & SEYMOUR porcelains made many new friends at the Convention owing to the presence of Manager B. E. Salisbury, who came on from Syracuse and was assisted by John Brooks and F. M. Hawkins, of the Chicago and New York offices, respectively.

FRANK G. BOLLES, of the Bullock Electric Manufacturing Company, Cincinnati, distributed one of the handsomest souvenirs at the Convention. It was a finely-executed medal charm showing a Bullock generator, and was of convenient size for the watch chain.

FRANKLIN ELECTRIC MANUFACTURING COMPANY, Hartford, Conn., was fortunate in having its interests taken care of by J. Camp, Jr., and G. D. Curtis, who interested many visitors in the "Femco" incandescent lamps this company is manufacturing.

MANHATTAN GENERAL CONSTRUCTION COMPANY, Newark, N. J., manufacturers of the well-known Manhattan A. C. series enclosed-arc system, was ably represented by S. Marsh Young and W. C. Hubbard. Mr. Young was accompanied by Mrs. Young.

NEW YORK & OHIO COMPANY, Warren, Ohio, had W. D. Packard at the convention, where he interested many of the central-station men in the well-known Packard lamps and transformers. His company is also doing a gratifying business in the manufacture of automobiles.

JAMES WOLFF, the Western manager of the New York Insulated Wire Company, and without whom no convention would be complete, was present as usual and renewed many old acquaintances and made many new friends for his company. P. H. Hoover was also present.

J. G. POMEROY, one of the best-known men in the Western electrical fraternity, was present in the interests of the well-known Adams-Bagnall arc lamps. Mr. Pomeroy is the general Western sales agent of the Adams-Bagnall Company, Cleveland, with headquarters in Chicago.

CHICAGO BOILER CLEANER COMPANY, Pittsburg, exhibited its boiler-cleaning apparatus and electric oil filter to many interested parties in the hotel lobby. President G. W. Atterbury was present and distributed free to oil users a microscope for testing the purity of oils.

DR. W. M. HABIRSHAW and J. W. GODFREY represented the India Rubber and Gutta Percha Insulating Company. Few are better known to the electrical fraternity than these genial gentlemen, and without them the convention would have sadly missed two of its most popular attendants.

F. C. SUTTER, who has done so much to place his company, the Pittsburgh Transformer Company, in the front rank of manufacturers, was at the Convention, and stated that business was excellent and that his factory was taxed to its utmost capacity night and day to keep up with its orders.

THE NEW ENGLAND ELECTRIC MANUFACTURING COMPANY, Boston, earned the warm regard of the ladies and gentlemen present by its lavish distribution of carnations through its representative, C. W. N. Money. This exhibition of thoughtfulness and courtesy was much appreciated.

THE STANLEY INSTRUMENT COMPANY'S New York office sent Samuel O. Ochs as its representative, who looked after the company's interests in the absence of General Sales Agent Francis H. Wall, who was unable to be present, and whose absence was much regretted by many of his friends.

THE E. G. BERNARD COMPANY, Troy, N. Y., was represented by its genial president, E. G. Bernard, whose wide acquaintance in the electrical field, coupled with an intimate knowledge of the electrical business, and indefatigable energy, have built up a large and prosperous business for his company.

THE AMERICAN DISTRICT STEAM COMPANY OF LOCKPORT, N. Y., was represented by J. H. Babcock and C. R. Bishop, who interested many of the central-station men in the merits of their system of profitably utilizing for heating purposes the exhaust steam which is now wasted in so many lighting plants.

WARREN ELECTRIC & SPECIALTY COMPANY, Warren, Ohio, the rapid development of whose various enterprises in the past few years bears such convincing testimony to the merits of the company's apparatus, was represented by Secretary and Treasurer E. W. Gillmer, and General Sales Agent T. H. Lane.

C. O. BAKER, JR., was present in his dual capacity of representative of his company, Baker & Co., of Newark, N. J., the well-known platinum refiners, and as master of transportation for the Association. Mr. Baker was indefatigable, as usual, in his efforts to contribute to the comfort and pleasure of the Convention visitors.

STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, whose staff are among the most courteous and deservedly-popular members of the electrical fraternity, was represented at the Convention by J. V. Marsh, of Pittsburg; T. E. Hughes, of the Philadelphia office, and C. J. Marsh, of the New York and New England territory.

UNITED STATES CARBON COMPANY, Cleveland, was represented by its popular sales manager, Norman McCarty, who made many friends for his product. The company is pushing its business vigorously and the appointment of the receiver has had no effect on its ability to accept and execute all contracts and fill all orders promptly.

THE STANDARD PAINT COMPANY, New York, distributed a very attractive souvenir in the shape of a paper cutter which was much appreciated by those fortunate enough to receive one. Ralph L. Shainwald, president; Walter Cary, vice-president; J. C. Shainwald, western manager, Chicago; and F. F. Vandewater, New York, were present.

ELECTRIC MOTOR & EQUIPMENT COMPANY, Newark, N. J., sent G. E. Davis, who exhibited to many interested visitors some of his company's universal sign receptacles, a system of units from which may be quickly formed, wired and installed anything in the shape of thoroughly weatherproof electric signs or electric decorations of any style or variety.

SPRAGUE ELECTRIC COMPANY was ably represented by Alex. Henderson and H. G. Issertel, this being Mr. Issertel's first convention in the Sprague Company's interests. Mr. Henderson had charge of the company's interior-conduit interests and Mr. Issertel missed no opportunity to remind delegates that Lundell dynamos and motors were available for any sort of direct-current service.

THE GENERAL ELECTRIC COMPANY had a large delegation present, who entertained the attendants in the company's usual hospitable manner in parlors on the first floor. Among the company's representatives were F. W. Willcox and A. D. Page, incandescent lamp works; E. E. Gilbert, J. R. Lovejoy, H. W. Hillman and W. LeRoy Emmet, of the lighting department; E. A. Carolan, foreign sales department; E. H. Mullin and M. A. Oudin.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY occupied parlors on the second floor of the hotel, but did not make any exhibit—none was necessary, as Westinghouse apparatus at the big Niagara Falls power houses constituted a far more effective exhibit than any array of "show" apparatus possibly could have done. The company was represented at the Convention by H. P. Davis, H. C. Ebert, J. S. Peck, W. M. Probasco, F. H. Taylor, E. M. Tingley, A. J. Wurts and C. F. Scott, of the Pittsburg offices; E. W. S. Gray, F. B. H. Paine and Calvert Townley, New York; W. F. Fowler, D. E. Manson and R. L. Warner, Boston; Paul T. Brady, Syracuse; N. S. Braden, Cleveland; W. C. Armstrong and C. F. Medbury, Detroit; E. A. Eames, T. C. Frenyear and C. W. Underwood, Buffalo; L. E. Imlay, Niagara Falls.

THE GOULD STORAGE BATTERY COMPANY had an efficient exhibit in the lobby of the International Hotel. There were shown plates formed and unformed, both positive and negative, from the smallest to the largest size. Among them were plates which had gone through a series of discharges representing over a year's work in ordinary use, and showing apparently no depreciation. The number of discharges to which they had been subjected was 317, with over 100 at a twenty-minute rate, the same number at a half-hour rate, and one, three and eight-hour rates. "Spinning," the special method employed by the Gould Company for sub-dividing the lead and obtaining a large contact surface for the active material, was entertainingly explained by Mr. W. W. Donaldson, and exemplified by numerous samples, showing a ratio of 20 to 1 and as high as 450 square inches per pound of lead. An automobile type was shown, which with 18 lbs. of element, will give 100 ampere-hours at a four-hour rate. There were also shown different types of plates which had been recently installed at Mr. W. K. Vanderbilt's residence, Oakdale, L. I.; the Commercial Office Building, New York City; the Edison Station, Canton, Pa.; Lansing, Mich., Street Railway.

Telephone Convention Notes

J. F. KERBIN came on from Kokomo, Ind., in the interest of the Laclede Battery Company.

THE ERICSSON TELEPHONE COMPANY, New York, was represented by L. P. Smith.

AMERICAN BATTERY COMPANY of Chicago was represented by Secretary C. S. Kaufman.

THE McROY CLAY WORKS, Brazil, Ind., was represented by E. F. Kirkpatrick, Chicago agent.

THE PHOENIX ELECTRIC TELEPHONE COMPANY of New York was represented by D. P. Scott.

THE AMERICAN VITRIFIED CONDUIT COMPANY, New York, was represented by B. S. Barnard.

VARLEY DUPLEX MAGNET COMPANY, Phillipsdale, R. I., was represented by C. L. Hibbard, of the Chicago office.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, was represented at the Convention by O. C. Cathoff.

UNION SWITCHBOARD COMPANY, Erie, Pa., had the merits of its system explained to many interested visitors by John J. Miller.

I. J. KUSEL, one of the best-known men in the telephone field, looked after the interests of the Eureka Electric Company of Chicago.

H. C. DODGE, general manager, and L. Sands were present in the interest of the Williams-Abbott Electric Company of Cleveland.

THE AMERICAN ELECTRIC FUSE COMPANY, Chicago, was represented by President F. W. Jones, J. A. Kenny and P. A. Allison.

THE CENTRAL ELECTRIC COMPANY of Chicago sent A. S. Pearl to look after its interests at the Convention, and he "looked" to good effect.

STERLING ELECTRIC COMPANY, whose factory in Lafayette, Ind., is crowded with orders, was represented by W. E. Doolittle and F. B. Clark.

W. J. WATSON, of New York, and E. H. HAMMOND, of Chicago, were present in the interests of the American Electrical Works, Providence, R. I.

THE BOSTON CABLE CLIP was kept in evidence by samples which were freely distributed by H. P. Moore, of the Chase-Shawmut Company, Boston, Mass.

THE HIPWELL MANUFACTURING COMPANY, Allegheny, Pa., displayed some of its high-grade long-distance telephones, and was represented by H. H. Hipwell and T. Hipwell.

ELECTRIC APPLIANCE COMPANY, Chicago, occupied parlor 222 at the Iroquois, where A. L. Millard and S. A. Densmore showed some of the telephone specialties of the company.

H. J. JAEGER attended the Convention and interested many of the visitors in telephone switchboard lamps, which are a specialty of the American Decorative & Miniature Lamp Company of New York.

S. B. CONDIT, JR., was on from Boston and interested many of the telephone construction men in the Cameron system of cable-placing machines and hangers which his company is introducing.

THE COUCH & SEELEY COMPANY of Boston had an interesting exhibit in one of the parlors of the Iroquois, and distributed some very attractive souvenirs. E. B. Seeley represented the company.

STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, Pa., was represented by C. L. Wiley, of New York; T. E. Hughes, of Philadelphia; J. R. Wiley, of Chicago, and A. V. Sauerman, of Boston.

THE WILLIAMS ELECTRIC COMPANY, Cleveland, Ohio, displayed some of its more notable products in one of the parlors, and was represented by J. A. Williams, president and general manager, and J. A. Stratton.

F. F. SAPP distributed souvenir "good-luck" pieces for the North Electric Company of Cleveland, Ohio, which was also represented by Messrs. North, Steele and Hendrickson, and its Chicago agent, George W. Conover.

THE GENERAL ELECTRIC COMPANY was represented by F. W. Willcox, of the Edison Miniature Lamp Department, Harrison, N. J., which is meeting with a large demand for miniature signal lamps for switchboard work.

C. E. FARR, president of the Farr Telephone & Construction Supply Company, Chicago, disappointed many of his friends by not going to the Convention. He had originally intended to be present, but was prevented at the last moment.

THE AUTOMATIC TELEPHONE METER COMPANY, Boston, Mass., illustrated its new automatic-meter system by means of a small switchboard and two subscribers' instruments connected thereto with automatic meters at each instrument.

THE AMERICAN TOLL TELEPHONE COMPANY, Cleveland, distributed a pamphlet illustrating and describing their automatic pay-station apparatus which has been meeting with so much favor. The company was represented by W. A. Foss and E. F. Kaneen.

ROTH BROTHERS & COMPANY, Chicago, were represented by G. A. Roth. This company is doing an extensive business in small motor-generator sets for telephone exchanges, one of which was on exhibition in the American Toll Telephone Company's booth at the Pan-American Exposition.

JOHN A. ROEBLING'S SONS COMPANY, Trenton, N. J., as usual sent a large delegation, which included W. G. Quigley, of Trenton; W. T. Bowman, of Cleveland, and W. N. Slughiff, of Chicago. G. W. Swann, who looks after the company's interests at the Exposition, distributed pliers among the visitors.

THE CENTURY TELEPHONE CONSTRUCTION COMPANY, Cleveland, was represented by Messrs. Hubbell and Moore. This company carries a full line of magneto and central-battery switchboards, lamp-signal multiple switchboards, central-battery telephones, and 'phones for interior and hotel systems.

HOLTZER-CABOT ELECTRIC COMPANY, Brookline, Mass., distributed a "butterfly" souvenir which attracted much attention among the visitors. The company showed some of its specialties in parlor 222 of the Iroquois, and was represented by C. W. Holtzer, T. W. Ness and W. H. Holland, of Brookline, and E. R. Harding, of Chicago.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Chicago, had a large delegation present, which included A. Stromberg, Paul M. Krahmer, E. L. Brown, S. Curtis, C. W. Stiger, William Davis, H. Shafer and P. J. Hertz. This company's exhibit is one of the largest and most interesting in the Electricity Building at the Pan-American Exposition, and is described elsewhere in this issue.

THE CLARK AUTOMATIC TELEPHONE SWITCHBOARD COMPANY, Providence, R. I., was represented by J. L. Putnam, L. A. Stillings and F. Ingraham, who entertained many visitors at the company's space in the Electricity Building at the Pan-American Exposition. The Clark is an automatic switchboard system which does not require any central-office operator, and it is adapted to factory and small town exchanges up to 150 subscribers' stations.

THE COLUMBIA TELEPHONE MANUFACTURING COMPANY, Chicago, was represented at a telephone Convention for the first time. J. G. Nolan was present in the company's interests, and exhibited some of its specialties, the leading feature of which was a switchboard with the subscribers' circuits terminating on a plug and tip, and having jacks on the ends of the cords, thereby reversing the usual arrangement and making what is termed an "anti-dust" switchboard.

THE KELLOGG SWITCHBOARD & SUPPLY COMPANY, Chicago, had a large delegation present which entertained visitors both at the convention and at its handsome booth in the Electricity Building at the Pan-American Exposition, where the company has on exhibition samples of its switchboard work on a very large scale. A handsome card-case souvenir was much appreciated by many of the telephone men visiting the booth. Among those present for the company were M. G. Kellogg, Charles L. Myers, F. J. Dommerque, Paul Bossert, A. E. Barker, of Cleveland, and Mr. Platt, of New York.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, Chicago, entertained many of the delegates at its pavilion in Electricity Building. S. J. Bear, designed, installed and has charge of the exhibit. A large central-energy multiple switchboard had been delayed because of rush of business at the factory, but a 100-line Bell-type switchboard, a 300-line cross-connecting board and a 100-line American express board were in place, and a large number of switchboard appliances were shown. A power board is supplied with current from a Roth motor-generator. A handsome case facing the main aisle displays the smaller parts. Twenty-six types of telephone instrument are shown including central-energy and magneto call instruments for general and special uses. The Warner ringing machine is also shown in this space. This is a substitute for magneto or motor-generator central-office ringing, which consists of a battery of 40 to 60 cells, the circuit from which is interrupted and alternated by a vibrating pole-changer kept going by a cell of Edison-Lalande battery.

THE COUCH & SEELY COMPANY, Boston, Mass., had a very complete line of its representative products in Parlor 72 at the Iroquois, in charge of E. B. Seely and A. F. Boardman. Among the things of special interest in the display were a listening and ringing key, unusually perfect as to details, and two styles of intercommunicating call-box, one of which was a key-box in which the contact is established and ringing done by the same key and in which only one key will stay depressed at a time, making confusion in calls impossible. The other was a plug box. The outdoor outfit used extensively on electric railway interurban lines and for a police patrol box also attracted considerable attention. In this instrument the shutting of the door cuts out the instrument so that it is only in circuit when the door is open. A hotel set of the same type that the company made for the Essex Hotel at Boston was shown alongside the regular set used in the Iroquois Hotel, and the contrast was striking, as the Couch & Seely set was only about a quarter the size of the other.

THE LAMBERT SCHMIDT TELEPHONE MANUFACTURING COMPANY, New York, had an exhibit in Parlor 80 at the Iroquois Hotel, which elicited much favorable comment. The newest features shown were 6-drop and 10-drop portable switchboards for army and other service. The connections are made by means of cam keys similar to ringing keys, instead of plugs and jacks. There are three rows of cams on the 10-drop board, and each line has a terminal on three cams. If No. 1 and No. 2, for example, should wish to talk, the cams 1 and 2 in the first row would be thrown. The cams on the next row would be used should other parties wish communication, and so on until all are occupied. A small semi-portable board using plugs and jacks was also shown; this does not give, however, the rapidity of operation and portability of the cam board. Intercommunicating instruments were also shown in many types. All are fitted with automatic flyback switches which return to the "off" position when the receiver is hung up. All the outfits are provided with head micro-telephones of very strong, handsome design, or with regular transmitters and receivers, as preferred. One decidedly new kind of telephone designed expressly for the convention was in operation in the parlors. Attempts to call on this telephone was responded to by the flying open of the battery box, when it was found that the battery was charged with cigars. Lambert Schmidt, president of the company; W. W. Bostwick, Jr., and Mr. Schwartz were in attendance.

OBITUARY.

JOHN WARING, president of the Franklin Electric Manufacturing Company, Hartford, Conn., met with an untimely death on June 9 as the result of a gasoline explosion in a small detached building at his company's works on June 7. Mr. Waring would have suffered no serious injury from the explosion but for his chivalry in going back into the burning building to save two of the girl operatives in the experimental department. His burns were not serious, but it developed that he must have inhaled the flames, and the most strenuous medical efforts did not avail to prevent his death. Mr. Waring was born in Wisconsin 39 years ago; he graduated from Cornell University and went to Hartford about 10 years ago, at which time he brought out the Waring incandescent vapor lamp, which became well known. The wide use of this lamp was prevented, however, by suits for infringement brought by the Edison interests. After remaining in Hartford for some years, he went to Manchester and was associated with the Mather Electric Company until that company discontinued operations. He then returned to Hartford and was associated with the Perkins Electric Switch Company. About a year ago he formed a partnership with Mr. Jonathan C. Camp, and established the present business of the Franklin Electric Company. Mr. Waring leaves a mother and sister.

JOHN W. DICKERSON, one of the best-known and most universally-liked of technical journalists, died suddenly in Brooklyn on May 30. Mr. Dickerson had been in poor health for six or seven years, and had spent the past four years in Colorado, hoping to recover good health. While his stay in Colorado resulted in the eradication of an asthmatic trouble for the relief of which he went to that State, he suffered a paralytic stroke two years ago from which he apparently never entirely recovered, and which is thought to have been the indirect cause of his death. Mr. Dickerson was born in Philadelphia in 1861. During his earlier years he lived in Chicago, where he prepared for and ultimately entered the old University of Chicago. Before finishing the course at the University he removed to Rochester, N. Y., where he entered the University of Rochester, from which he was graduated with high honors in 1883.

After leaving college Mr. Dickerson took up daily newspaper work, in which he was conspicuously successful. He was an accurate, fluent and graceful writer, of keen intellect, and had an exceptionally well-developed analytical faculty. In 1888 he became a member of the editorial staff of the "Western Electrician," and assisted notably in the development of that journal. He was later connected successively with the "Street Railway Journal," "Street Railway Review" and "Street Railway Gazette," resigning from the editorship of the latter paper in 1896 to go to Denver for the benefit of his health. During his stay in Denver Mr. Dickerson contributed to the technical press several articles of value concerning mining operations in and around the Cripple Creek district.

Mr. Dickerson was a thoroughly honorable. loyal man, of a genial disposition yet entirely free from dissipated habits or other objectionable characteristics; his death is sincerely mourned by a large number of friends. His surviving relatives are his mother, Mrs. Emma R. Dickerson, and two sisters, the Misses Julia and Grace Dickerson, of Newton Center, Mass., and a brother, Mr. J. S. Dickerson, of Chicago.

PERSONALS.

MR. E. L. REYNOLDS, for a number of years connected with the New York staff of the Electric Storage Battery Company, has been appointed manager of the Pennsylvania sales office of that company.

MR. GEO. F. LEMON, who was for some time past superintendent of motive power of the South Covington & Cincinnati Street Railway Company, has joined the forces of Wickes Bros., manufacturers of boilers, heaters, etc., and will be connected with the Chicago office of that firm.

MR. C. C. MAJOR, who has been for several years one of the most valuable members of the staff of assistant professors in experimental engineering at Sibley College, Cornell University, has resigned his position there to accept a position in the University of California, at Berkeley, Cal.

MR. GRENVILLE A. HARRIS, formerly of the engineering staff of the Westinghouse Electric & Manufacturing Company, and now with the New York office of Takata & Co., of Tokio, London and New York, was married on June 27 to Miss Blanche Sheffer, of Baltimore, Md. Mr. and Mrs. Harris will spend the summer season at Ocean Grove, N. J.

MR. AND MRS. THOMAS I. STACEY, of Chicago, were recently visitors to Philadelphia, where they were entertained by Messrs. Chas. M. and E. Ward Wilkins, of the well-known firm of Partrick, Carter & Wilkins, whose annunciators and electrical house goods form an important feature of the business of Mr. Stacey's company, the Electrical Appliance Company. Mr. and Mrs. Stacey will no doubt return to the west with extremely pleasant recollections of Philadelphia, as the Messrs. Wilkins are noted for their ability in entertaining.

TRADE PUBLICATIONS.

NON-ARCING FUSES. The D. & W. Fuse Company, Providence, R. I.—This is catalogue No. 8, made up in convenient vest-pocket size, and containing illustrations and prices of this company's well-known line of cartridge fuses, junction boxes, combined fuses and sneak coils for telephone service, plug fuses, etc.

ELECTRICAL SPECIALTIES AND NOVELTIES. E. J. Tardie & Co., New York.—A 16-page pamphlet, pocket size, in which are described many attractive electrical novelties, such as an electrical alarm clock with an incandescent-lamp attachment for illuminating the dial, portable electrical candles, portable call-bell outfits, electro-medical apparatus, battery fan motors, etc.

CORLISS ENGINES. The Murray Iron Works Company, Burlington, Iowa.—This is catalogue No. 50 of this well-known company, and it contains illustrations and descriptions of the company's standard Corliss engines, which are built in sizes ranging from 50 to 3000 horse-power. The catalogue is profusely illustrated by engravings of excellent workmanship and possesses the merit of actually describing the constructive features of the engine and not presenting a lot of superficial information which is of no interest to a prospective buyer.

TELEPHONE INSTRUMENTS AND APPARATUS. Western Electrical Supply Company, St. Louis, Mo.—A number of bulletins bound in catalogue form, in which are described complete lines of telephone apparatus, instruments, constructional material and accessories. The bulletins describe a considerable number of new devices for the economical operation of telephone lines in noisy places; a bridging telephone set designated the "Ideal;" and an attractive-looking receiver having a covered diaphragm.

BUSINESS NEWS.

THE BABCOCK & WILCOX COMPANY, New York, has removed its offices from 29 Cortlandt to 85 Liberty Street.

THE MASON REGULATOR COMPANY, Boston, Mass., has removed its offices to 158 Summer Street, on the corner of Federal Street.

U. S. WIRE CONDUIT COMPANY, New Kensington, Pa., has just moved into its new factory, and is now in a position to ship its well-known flexible enameled-wire conduit in any quantity.

THE GARL ELECTRIC COMPANY, Akron, Ohio, manufacturer of telephone apparatus, has been reorganized, and will hereafter be under new management. The company has also moved into a new and larger factory.

THE PHELPS COMPANY, formerly of Elmwood, Ill., manufacturer of the well-known Hylo baby-filament incandescent lamp, has removed its headquarters to its new factory at the corner of State and Rowland streets, Detroit, Mich.

THE WESTON ELECTRICAL INSTRUMENT COMPANY, formerly of Newark, N. J., has moved into its new factory at Waverly Park, Essex County, N. J., where facilities superior even to the excellent equipment of the Newark factory will be enjoyed.

GENERAL INCANDESCENT ARC LIGHT COMPANY, New York, has demonstrated its willingness to share the current prosperity with its employees by arranging to run its factory 54 hours a week and pay the same wages that were paid when the factory was running on a 60-hour basis.

CENTRAL ELECTRIC COMPANY, Chicago, has issued a new price-list and discount sheet dated May 1st, which applies to its general catalogue. Customers who are in possession of the general catalogue and who did not receive a copy of the new discount sheet will be supplied with a copy upon reporting the omission to the company.

THE GOLD CAR HEATING COMPANY, New York, recently won an important patent suit in Canada, which was brought by the Consolidated Car Heating Company for infringement of the Sewall patent steam hose coupler. The Court of Appeals at Montreal unanimously decided that the Gold coupler does not infringe the Sewall patent in any way.

THE LAMBERT SCHMIDT TELEPHONE MANUFACTURING COMPANY, New York, has purchased the equipment and material of the Bruckner Electric Company, which, combined with the excellent factory equipment already possessed, will give the Lambert Schmidt Company exceptional facilities for turning out its well-known apparatus.

THE STILWELL-BIERCE & SMITH-VAILE COMPANY, Dayton, Ohio, reports that its engineer, Mr. Folsom, has just returned from Canada bringing with him an extensive order for Victor high-pressure water wheels to operate under a 240-ft. working head. The order includes two 1000-h.p. wheels, one 500-h.p. wheel and one of 100 horse-power.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, is enjoying a particularly fine export trade in Cross oil filters. Among recent sales was a complete equipment of filters for the immense English works of Vickers, Sons & Maxim, the largest manufacturers in the world of war material. Another equipment was sold to the San Juan Light & Transit Company, Porto Rico.

WOOLSTON & BREW, New York, with New England offices at 34 Ames Building, Boston, in charge of Mr. Lee W. Woolston, have made arrangements to represent the Ball Engine Company, of Erie, Pa., in the New York and New England territories. This firm has been for some time the selling agents for C. H. Brown & Co., of Fitchburg, Mass., and has made a highly creditable record in steam-engineering circles.

THE SHELBY ELECTRIC COMPANY'S New York office has been removed to the Parker Building, corner Fourth Avenue and Nineteenth Street. The export department of

A COMMUTATOR NECESSITY.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.

50c. per Stick. $5 00 per Dozen.

For Sale by all Supply Houses.

Upon receipt of this coupon we will send FREE, sample stick.

Name ....
Address ..
A. E.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO

the company will also be located at the same place. The new offices will be provided with a fully-equipped laboratory where the company will test, without charge, any make of incandescent lamps for consumers, in order to demonstrate the claims made for its product.

THE ALBERENE STONE COMPANY, of New York, Boston and Chicago, recently entered the electrical field with Alberene stone, which is particularly well adapted for switchboards and any other purposes where slate or marble is ordinarily used. Among the superior qualifications claimed for this product is that the heat of an arc does not cause it to crumble. Inquiries and correspondence may be addressed to the Chicago, Boston or New York office.

STEPHENSON MANUFACTURING COMPANY, Albany, N. Y., has obtained the sole agency for the National automatic four-speed cylinder lubricator, and also for the Rollins self-expanding boiler-tube cleaner. The National cylinder lubricator is truly automatic, requiring no attention whatever beyond keeping the reservoir filled. The Rollins tube cleaner is of the automatic expanding scraper type, made either with a brass body or of malleable iron.

THE KARTAVERT MANUFACTURING COMPANY of Wilmington, Del., manufacturer of hard and flexible fibre for electrical and mechanical purposes, reports that its business has grown to such an extent as to necessitate arrangements for an addition to the factory. The contract has therefore been let, and work will at once be commenced on the addition, which will, when completed, give the factory more than twice its present capacity.

WILLIAM ROCHE, manufacturer of dry batteries, has received a very flattering letter from the McIntosh Battery & Optical Company, regarding a set of No. 8 Roche batteries, which, it is said, was set up last February, and has been in use ever since, the service to which they are put being the calibration of voltmeters. A recent test, it is stated, showed a decrease in voltage of less than two per cent. It is also stated that none of the cells has swelled or shown any signs of deterioration.

THE McROY CLAY WORKS, Chicago, has removed its offices from 915 Chamber of Commerce Building to 1029-1030 Monadnock Block. Mr. E. F. Kirkpatrick, well known in electrical circles, is now sales manager of the McRoy Clay Works, and will be pleased to see all of his friends at his new location in the Monadnock. "Kirk" says he is pleased to have gotten out of the atmosphere of lawyers and judges, and to be in a place where he can daily see the faces of his familiar friends.

ROBERT W. BLACKWELL & CO., of London, Cardiff, Paris, Brussels and New York, announce that the report to the effect that the Paris office is about to be closed up is entirely untrue. The former manager of the Paris office, Chanlaqui Beuret, has resigned his position, and the services of a number of former employees at the Paris office have been dispensed with, but there is not the slightest intention of closing the Paris office. Messrs. Eugene Estervard and F. W. Vallat will be retained as assistants in the management of the office.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, has recently taken the exclusive territorial agency for the Browning spherical steel-clad motors and dynamos. These machines are made in sizes of from 1/5 to 3½ horse-power and ⅛ to 2½ kilowatts, and have met with instantaneous success. These motors were designed to be used where a high grade, strong and compact machine is necessary, and are especially adapted for all moderate power work, such as that of small manufacturers, jewelers, hotels, clubs and restaurants, or for small private lighting plants.

THE GOULD STORAGE BATTERY COMPANY, New York and Depew, N. Y., has found it necessary to enlarge its shops in order to accommodate the growing demand for its well-known storage battery. The company has recently changed its electrochemical process of formation, so that the Gould automobile type of battery gives an output of from 10 to 12 watts per pound. It is stated that Gould negative plates never give out, and the company claims to have some 20,000 vehicle cells in operation, some of which are over two years old and have not yet shown signs of collapse.

THE AMERICAN ELECTRIC FUSE COMPANY, of New York and Chicago, has just perfected a new telephone fuse which is claimed to have many points of superiority. The new fuse is enclosed between two pieces of mica, so as to prevent any possibility of breakage. The wire is left slack between the terminals, so that the point of fusing is more reliable than when the wire is under tension. Another advantage possessed by the new fuse is that no amount of rough handling seems to injure it. It is made to fit any standard fuse-block on the market, and can also be furnished in any special shape or design.

THE NEW PROCESS RAWHIDE COMPANY, Syracuse, N. Y., recently shipped one of its rawhide pinions to Germany, to be used on the private yacht of Kaiser Wilhelm. This company reports that export sales of New Process pinions are rapidly increasing. A shipment of 100 pinions for G. E. railway motors recently went to London, and another shipment has been made to the Albion Motor Company, a big English automobile manufacturer. A number of railway pinions have also been shipped to Germany and Norway, and a good-sized order is in process of construction for one of the mines at Kilgourlie, Australia.

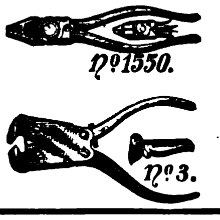
WISCONSIN GRAPHITE COMPANY, Pittsburg, Pa., has purchased the three-

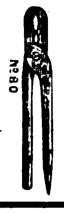
The Telephone Service is The Quickest Messenger.
Rates in Manhattan from $5 A MONTH. One Year Contracts. Monthly Payments.
NEW YORK TELEPHONE CO.
15 Dey Street. 111 West 38th Street.

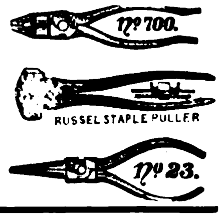
CREAM FLUX
An Absolutely Non-Corrosive Insulating Soldering Flux FOR ALL METALS.
So EASILY APPLIED that all CAN USE IT.
So CHEAP that all SHOULD USE IT.
So EFFICIENT that all MUST USE IT.
PUT UP IN CANS AT
15c., 25c., 45c. and 75c.
SPECIAL PRICES IN QUANTITY.
SEND FOR TRIAL BOX.
Endorsed by the National Board of Fire Underwriters and all users.
We guarantee it, and if not satisfactory, money will be refunded.
FOR SALE BY ALL SUPPLY HOUSES OR
CREAM FLUX CO., SOLE MANUFACTURERS, 100 Washington St., CHICAGO

BIG STICK, 35 CENTS.
Sample Free.
SOUTHWORTH & HARE,
Indianapolis, Ind.

HELLO! Let me give you some good advice
For the best Telephones of all kinds go to the
ERICSSON TELEPHONE CO.
296 Broadway, New York City






No 700.
RUSSEL STAPLE PULLER
No 23.

NIPPERS and PLYERS
SPLICERS and CLAMPS
If you have not used ours, examine the GREEN BOOK of Hardware Specialties.
SMITH & HEMENWAY CO.,
Utica Drop Forge & Tool Co.,
296 BROADWAY, - NEW YORK.

An INCANDESCENT LAMP represents a large investment of cap'tal, ingenuity and skilled workmanship, it is sold at a price so low as to necessitate eternal vigilance in cutting costs to a minimum. A successful lamp manufacturer can not afford to experiment with poor materials. This explains the popularity of
BAKER & CO.'S PLATINUM
408 N. J. R. R. Ave., NEWARK, N. J. 120 LIBERTY ST., NEW YORK
We buy and Refine Platinum Scrap also

story building in Alleghany formerly occupied by R. D. Nuttall Company for use as a factory. The company also purchased recently 120 acres of land at Stevens Point, Wis., which is said to be underlaid with graphite showing an analysis of 72 per cent pure. The company began operations on the first day of the present year, and its business has increased to such an extent as to necessitate increasing the capital stock from $100,000 to $300,000. The officers of the company are E. D. Steinman, president; H. R. Swearer, vice-president and general manager, and Fred J. Shaler, secretary and general sales agent.

SOMETHING OF AN INNOVATION in the lighting of large church auditoriums is shown in the lighting of the new Second Church of Christ, Scientist, Central Park West, New York. This edifice is beautifully lighted by a system of concealed reflectors placed in cornices in the ceiling, so graduated that a powerful but even and decidedly agreeable light is thrown over the whole auditorium, the source of the light itself being concealed from the eye. The effect produced is very fine indeed, and commends itself to any one studying the problem of successfully lighting a large auditorium, or any beautifully decorated interior or painted ceiling. I. P. Frink, of New York, is the originator of this effective method of lighting.

INSULITE is the name of a new insulating material which the American Hard Fibre Company, Newark, Del., has recently added to its well-known line. Insulite is somewhat similar in appearance to hard fiber, with which the trade is, of course, familiar, but is made by an entirely different process, and when finished is perfectly smooth, without puckers or wrinkles. It is made in thicknesses ranging from 0.003 in. to 0.0156 in., in rolls 47 ins. wide, weighing from 100 to 500 lbs., or in sheets about 36 x 47 ins. This material is particularly well adapted to the insulation of dynamo and motor windings. It does not absorb moisture to quite the same extent that hard fiber does on account of the calender ring. It is made either in the natural color, which is light gray, or in red or black.

THE BROWN-CORLISS ENGINE COMPANY is the name of a new concern recently incorporated at Milwaukee, Wis., with a capital of $1,000,000 for the purpose of building high-grade Corliss engines. The new company has purchased 1200 acres of land at Western Union Junction in Racine County, Wis., where a plant and manufacturing city will be erected. The buildings will be of brick and steel and equipped with the most modern machinery and appliances. Walter F. Brown, who has been connected with the Harris-Corliss, E. P. Allis and Filer & Stowell companies, is general manager and second vice-president of the new company. Walter S. Whitings, the first vice-president of the company, is a brother of C. W. Whitings, who, until recently, was connected with the E. P. Allis Company. The president of the new company is Julius Wechselberg.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., recently completed its new shops at Morningside, just a mile out from Pittsfield on the Boston & Albany Railroad, and reports that the orders already in hand are ample to keep the new shops running day and night for a year. The company recently added to the bonds of friendship already existing between its executives and employees by granting the latter a nine-hour working day with ten hours' pay and a 5 per cent increase in wages. The company has found it expedient in view of its rapidly increasing Southern trade to establish another sales office in the South; the new office is located at Winston-Salem, N. C., and is in charge of F. A. Barr. A branch sales office has been established also at 26 South Fifteenth Street, Philadelphia, in charge of James E. Cutler, late of the New York office.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has recently closed contracts for five chloride accumulator plants to be installed at rotary sub-stations on suburban electric roads about to be built in the vicinity of Pittsburg, Pa., by the same interests which now control the Monongahela Light & Power Company, the Monongahela Street Railway Company and the Pittsburg & Birmingham Traction Company. Three of these plants will be installed on the Pittsburg & Charleroi road now under construction, one will be located in McKeesport, and the fifth at Springdale, Pa., on the projected Alleghany Valley Street Railway. One of the important objects obtained by these battery installations is to permit current for both railway and lighting work to be taken from the same 60-cycle alternators, the batteries being used to smooth out violent direct-current fluctuations at the rotary converters which supply the railway circuits.

THE STANDARD PAINT COMPANY, New York, desires to warn the public against attempts to put on the market an inferior imitation of Ruberoid. The bogus article has been made to resemble Ruberoid closely in appearance and looks so much like the original article that buyers are likely to be misled. To prevent this the Standard Paint Company urges that rolls of any material presented as being Ruberoid be closely inspected with a view to identifying the trade mark with which the genuine Ruberoid is stamped. The company reports that Ruberoid is meeting with high approval abroad. In China, the U. S. and German barracks are covered with Ruberoid roofing; Ruberoid is also used in the De Beers Mines in South Africa, and in the Klondike fields in Alaska. Large quantities of this material, and of the well-known P. & B. paints, are sold annually in Germany, Austria, Spain, Italy, Russia, Egypt, Australia, West Indies, the Philippine Islands and the Hawaiian Islands.

A CONSPICUOUS SUCCESS.—The Philadelphia office of the Western Electric Company, the opening of which was noted in our June number, has proven a wholesale success from the very beginning. The office is already enjoying a large share of the trade from the territory which it is intended to serve, and the store rooms are crowded a good part of the time with customers and interested visitors. One of the features of the new store which has attracted a great deal of attention is the exhibit of phonographic apparatus. On the opening day, above referred to, a special phonographic entertainment was given on the eighth floor of the building, and this seems to have established a remarkable degree of interest in this class of apparatus, which does not show any signs of flagging. The Philadelphia office should prove a tremendous convenience to buyers throughout Pennsylvania and in the Southern States, as a complete stock of all of the company's standard lines is carried here.

THE NORTHERN ELECTRICAL MANUFACTURING COMPANY of Madison, Wis., through its Chicago office, has secured the contract for the entire equipment of the new central station being built by the Citizens' Electric Light Company, of Battle Creek, Mich. The installation will consist of one 275-kw. and one 135-kw. two-phase Stanley inductor alternator, together with station and sub-station switchboards, step-up transformers, etc. The larger unit will be belted to a water wheel of about 250 horse-power, and the smaller one will be driven by a Buckeye engine. On account of the limited and uncertain water power available, these generators will be operated in parallel, the smaller unit taking its load automatically in proportion to the power of the water-wheel. This means that the water-driven unit will at all times carry the bulk of the load, the engine-driven unit only being called upon when the power of the water-wheel falls below normal. The company's Chicago office has also secured a contract from the L. Wolf Manufacturing Company for a complete equipment of generators and motors to be installed in the immense works at Carroll Avenue and Roby Street, Chicago. The installation will consist of two 220-kw. 250-volt generators, direct-connected to Allis-Corliss engines, and operated at 110 r.p.m., with a full equipment of motors. These will all be slow speed, a number of them being entirely enclosed and arranged as far as possible for the individual driving of machines; the motors will range in size from 7½ to 80 horse-power each.

PRATT INSTITUTE
BROOKLYN, N. Y.
TWO YEAR COURSES IN
Applied Electricity
AND IN
Steam and Machine Design
Write for Catalogue and Particulars.

SOLID TRAINS TO NORTHERN MICHIGAN.

The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

THE MASON
Reducing Valves
ARE THE WORLD'S STANDARD VALVES

For automatically reducing and absolutely maintaining an even steam or air pressure.

They are adapted for every need and guaranteed to work perfectly in every instance.

Write for full information and splendid references.

THE MASON REGULATOR CO. Boston, Mass., U. S. A.

American Electrician.

Vol. XIII. New York, August, 1901. No. 8.

ELECTRICAL DISTRIBUTION OF POWER ALONG THE RIVER TYNE.

THE NEW CENTRAL STATION AT WALLSEND-ON-TYNE.

The first generating plant for the electrical distributing of power on a scale of considerable magnitude thus far built in Great Britain has just been completed at Neptune Bank, Wallsend, near Newcastle-on-Tyne, England. The enterprise was formally inaugurated by Lord Kelvin a few weeks ago, although as a matter of fact the plant had been supplying current locally for power purposes for some time previous to the ceremony. The plant is the outcome of a series of extensions of the old plant of the Newcastle Electric Supply Company, and has been established by that company in co-operation with the Walker & Wallsend Union Gas Company. The Newcastle company has been operating a single-phase station in Newcastle since 1892, and the gas company entered the electrical field in 1899 and laid plans for the Neptune Bank station. The two companies soon effected a combination by which the electric light company assumed the construction and operation of the projected plant and agreed to supply electric power "in bulk" to the gas company throughout the districts covered by that company's charter.

The system comprises a generating station at Neptune Bank and several sub-stations from which local distribution is effected. Three of these are located at Willington Quay, some three miles distant; seven are scattered about Newcastle and one is located at Gosforth, about six miles from the generating station, as the transmission lines run. The power station at Neptune Bank delivers three-phase alternating currents to the lines, at 5500 volts and 40 cycles. The sub-stations transform these currents to 440-volt three-phase alternating and 480-volt direct current. A rather singular feature of the sub-station distribution is that the 440-volt three-phase alternating current is distributed for power purposes, and the 480-volt direct current is distributed on the three-wire system for lighting and power purposes.

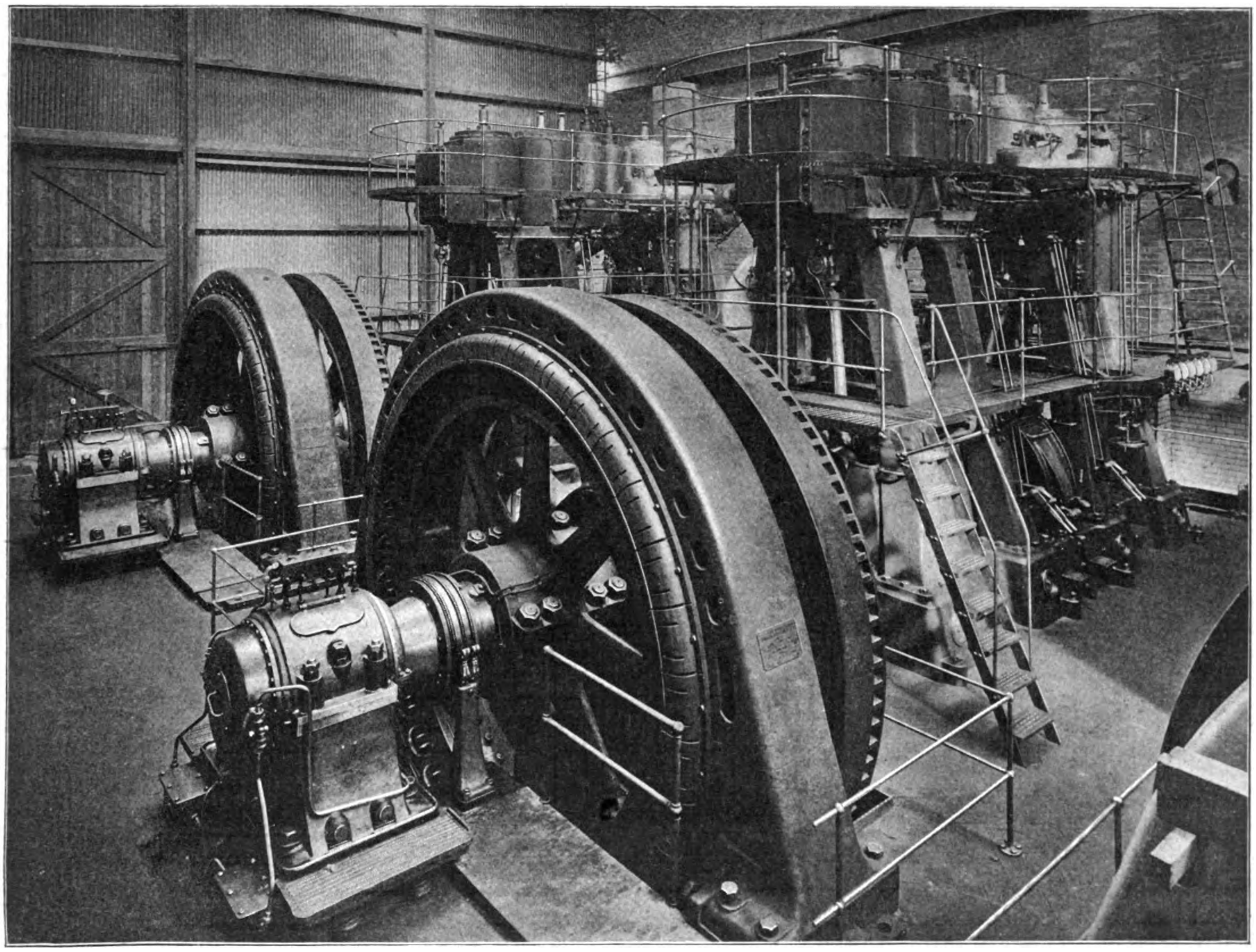


FIG. 1.—WIGHAM-RICHARDSON ENGINES DRIVING 700-K.W. THREE-PHASE GENERATORS AT NEPTUNE BANK POWER STATION.

The engine and generator room contains four principal generating units, consisting of 700-kw. alternators of the revolving-field type, direct driven at 100 r.p.m. by triple-expansion engines of the vertical marine type. There are also two direct-current generating sets, each consisting of two 100-kw. dynamos direct driven by a 300-h.p. Belliss engine and one 50-kw. machine driven by a 75-h.p. Belliss engine. The main engines are practically marine engines fitted with suitable governors and valve gear. The first of these was built by the Wallsend Slipway & Engineering Company. The cylinders of this engine are 17½ ins., 28½ ins. and 48 ins. in diameter, with a common stroke of 36 ins. They are steam-jacketed throughout and provided with Corliss valves all positively driven except the admission valves on the high-pressure cylinder, which are fitted with trip mechanism controlled by a chain-driven governor of the Proell type. In addition to the cut-off governor, there is an Aspinall governor which shuts off steam from the engine when the speed rises above 115 r.p.m.; the normal running speed being 100 r.p.m.

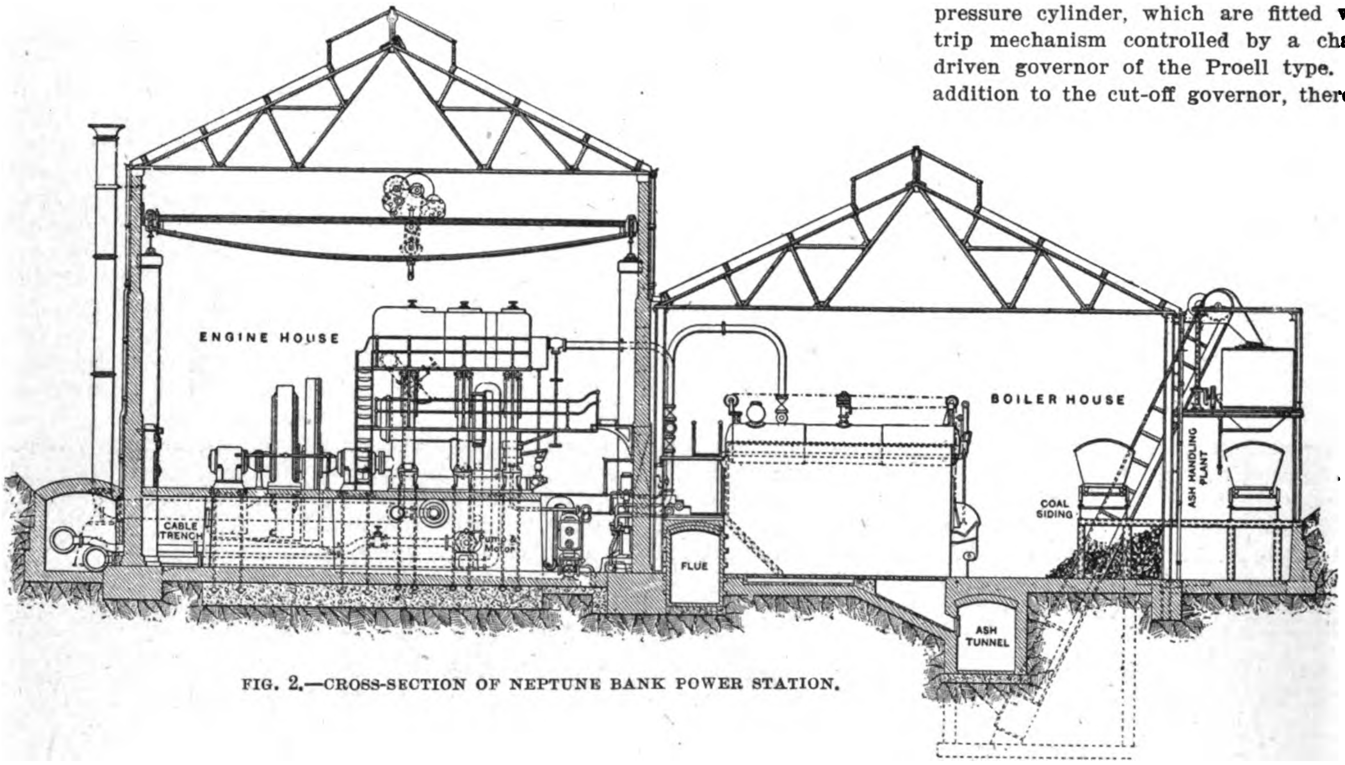


FIG. 2.—CROSS-SECTION OF NEPTUNE BANK POWER STATION.

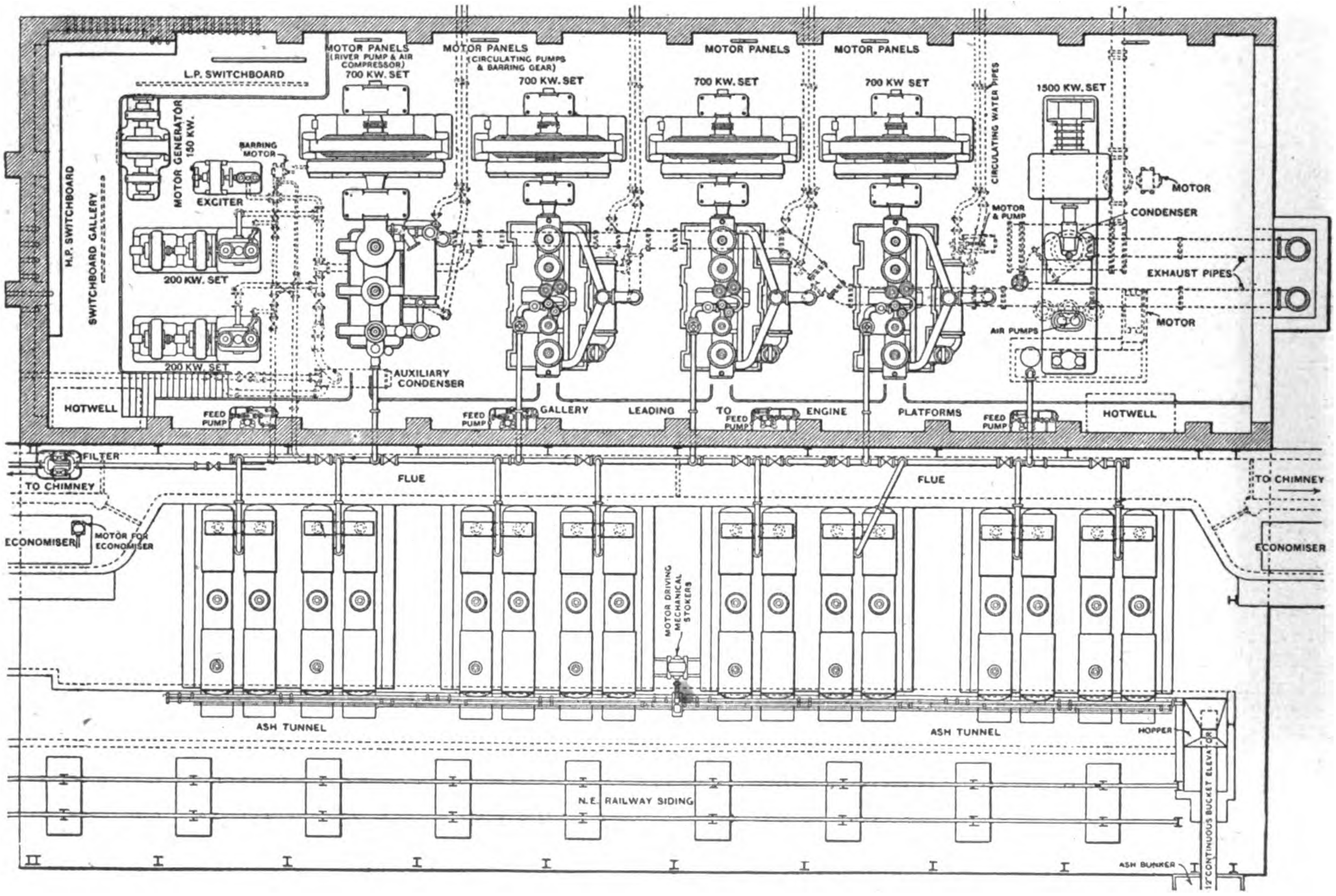


FIG. 3.—PLAN OF ENGINE AND BOILER ROOMS, NEPTUNE BANK POWER STATION.

The air pump is driven by a rocking lever linked to the high-pressure cross-head; the circulating pump is of the centrifugal type, driven by a direct-current motor. A surface condenser is employed; this is mounted on the back framing of the engine columns and provided with an automatic valve which opens the exhaust to the atmosphere in the event of failure of the circulating water.

The other three engines were built by Wigham, Richardson & Co., and are generally similar to the Slipway engine just described. The Wigham-Richardson engines, however, have two low-pressure cylinders, making four in all; the diameters are 19 ins., 31 ins., 34 ins. and 34 ins., with a 36-in. stroke. The four cranks are not set precisely 90° apart, but are balanced on the Yarrow, Schlich & Tweedy system with a view to eliminating all vibration and securing an even turning moment without the use of a heavy fly-wheel. The governor is of the fly-wheel type, mounted on the crank shaft. Fig. 1 herewith illustrates two of the Wigham-Richardson engines.

The alternators were built by the British Thomson-Houston Company. The field magnet spider is mounted on an extension of the engine shaft 24 ins. in diameter. The armature structure is arranged to slide parallel with the shaft on the base plates, so as to uncover the field magnet for inspection and repair. The frequency being 40 cycles and the speed 100 r.p.m., the field magnet has 48 poles. The armature core has one slot per pole per phase, and the winding is of the standard form-wound type, held in the slots by wooden wedges. The direct current for the field magnet excitation is supplied at 240 volts; this current is taken from the bus-bars of the dynamos driven by Belliss engines previously mentioned. These machines also supply the local three-wire direct-current distribution mains, for which reason the machines are divided into pairs, each pair being driven by an individual engine, as noted. These machines operated as simple shunt-wound dynamos give any voltage from 240 up to 270, running at 380 r.p.m.; operated as compound machines, they give 250 volts at no load and 262 volts at full load. The armatures are of the slotted-core type, drum wound, with the standard circular yoke ring used by the General Electric Company.

The Belliss engines driving these dynamos are two-cylinder compounds and are normally operated condensing. The exhaust passes through two Klein grease separators into a Wheeler surface condenser. The engine room also contains a motor-generator, consisting of a three-phase synchronous motor coupled to two direct-current dynamos, each having an output of 700 kilowatts. The synchronous motor is wound for the full transmission pressure of 5500 volts, and the direct-current dynamos are wound for 240 to 270 volts. The engine room equipment will ultimately be augmented by a 1500-kw. three-phase alternator driven by a Parsons steam turbine.

The boiler room equipment consists of eight Babcock & Wilcox boilers arranged in four batteries of two boilers each, as shown by the plan view, Fig. 3. The working pressure is 200 lbs. gauge. Each boiler has a heating surface of 4020 ft., and will evaporate 14,000 lbs. of water per hour. Variable feed mechanical stokers are fitted throughout, as shown in Fig. 4, as also are Babcock & Wilcox superheaters, the latter being designed to impart a superheat of from 100° Fahr. to 120° Fahr. to the steam. In addition to the

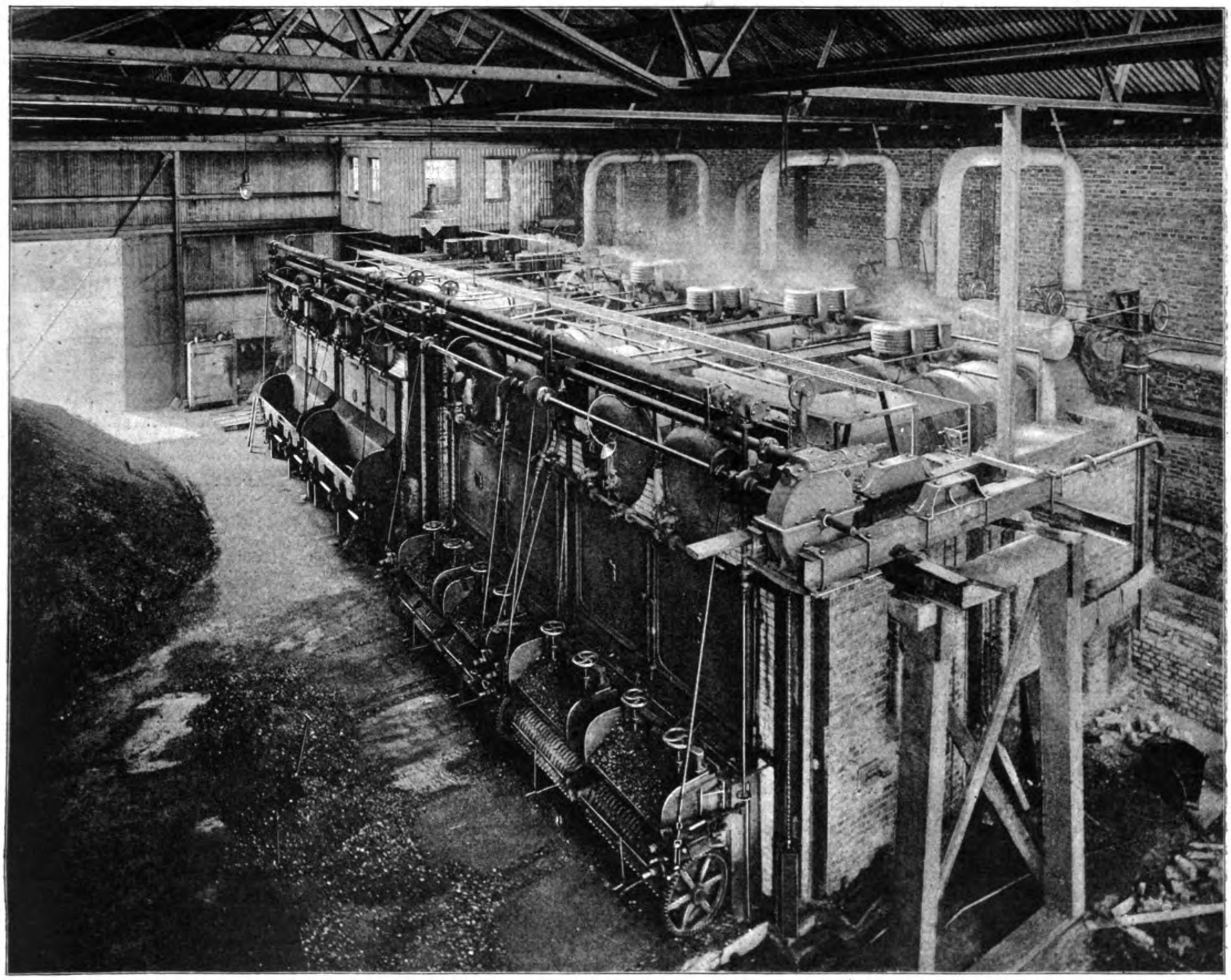


FIG. 4.—PARTIAL VIEW OF BOILER PLANT SHOWING VARIABLE FEED MECHANICAL STOKERS.

usual fittings, the boilers are provided with double blow-off cocks in series, duplicate feed valves and fixed soot-cleaning gear. At the back of each stoker are fixed automatic dumping bars so arranged that the ashes are discharged down a chute into a truck in the ash tunnel, at the end of which an elevator is provided. The remainder of the boiler-house equipment for the first section of boilers consists of a 280-tube Green economizer and two Rankine feed-water filters. All exposed portions of the boilers are covered to a depth of 2 ins. with magnesia non-conducting composition bound on with canvas, and a further covering of lead is provided on the top of the steam drums and other portions liable to mechanical injury.

The steam piping system (see Fig. 3) has been kept as short and simple as possible, the boilers being arranged symmetrically with regard to the main engines. One boiler is sufficient to drive a 700-kw. set at normal load. All steam pipes are of solid drawn steel tube with screwed or riveted wrought-steel flanges, both tees and valves having cast-steel bodies. All tees of 5 ins. and over, however, are made up by riveting a branch pipe directly to the main. Each of the boilers is connected through two valves to the main 7-in. header which extends the whole length of the boiler house, the valves in this header being so arranged that the boiler and engine plant can readily be split up into a number of complete units, each engine being fed from the boiler immediately behind it. In addition to this main header there is a smaller pipe running along the whole length of the boiler house about 6 ft. above the firing level, from which the feed pumps and Belliss sets are supplied.

The main header is divided into two halves by an inverted U expansion bend, each half being anchored at the middle point of its length, so that from this point it is free to expand in both directions, the weight being taken by long hangers. The steam valves are of the full-way type, and all valves above 6 ins. diameter are provided with by-passes. Drain pockets are provided on both main and branch steam pipes, and these discharge through traps into the hot-well. The covering is the same as that used on the boilers, and is provided for both steam and hot feed piping.

The high-tension switchboard was supplied by Messrs. Ferranti and consists of seventeen panels; namely, six generator panels, one motor-generator panel, two wattmeter panels and eight feeder panels, and is suitable for working at 6000 volts three phase. Each panel contains three fuses, three switches and three ammeters, and provision is made for disconnecting any panel from the bus-bar when alive by means of insulated tools. Bus-bar voltmeter and synchronizing gear in duplicate is provided at the top of the board. The two wattmeters are required for measuring the respective output of the two companies, as the gas company is supplied "in bulk." The switches are of the well-known Ferranti type for single-phase work, and the board has no back, the framework consisting of heavy slate panels grouted directly into the wall with vertical slates, dividing the whole into a number of recesses. A regulating table under the generator panels contains for each machine a hand-wheel connected to an "open type" regulating resistance (shown separately in Fig. 9), an ammeter in the field circuit of the alternator, and a double-pole carbon-break field switch The board is shown by Fig. 7.

The direct-current apparatus and output are controlled from three boards, two being on the floor level and one being in the switchboard gallery. These panels deal with the two 200-kw. Belliss sets, a small exciter set, and the 150-kw. motor-generator. One of the boards on the floor level contains the main dynamo fuses, the compounding switches, and the field switches. The main direct-current board is on the gallery and contains three sets of bus-bars; namely, the station power and lighting bus-bars, the exciter delivery bus-bars and the feeder bus-bars. The station bus-bars and exciting bus-bars are arranged one on each side of the system, so that the station power and lighting circuits and the alternator exciting circuits are each operated quite independently at 250 volts. In this way the exciting circuits are kept entirely distinct from anything else, thus greatly reducing the liability of any mishap to the excitation. Double-throw switches are provided by which any generating set can be thrown onto these bus-bars or onto the feeder bus-bars. The feeder bus-bars are connected through a wattmeter panel to the feeder board which is arranged for four sets of three-wire feeders, and also includes a traction panel for the supply of power to the shunting motor car in the yard outside. Fig. 6 is a diagram of all of the switchboard wiring in the power house.

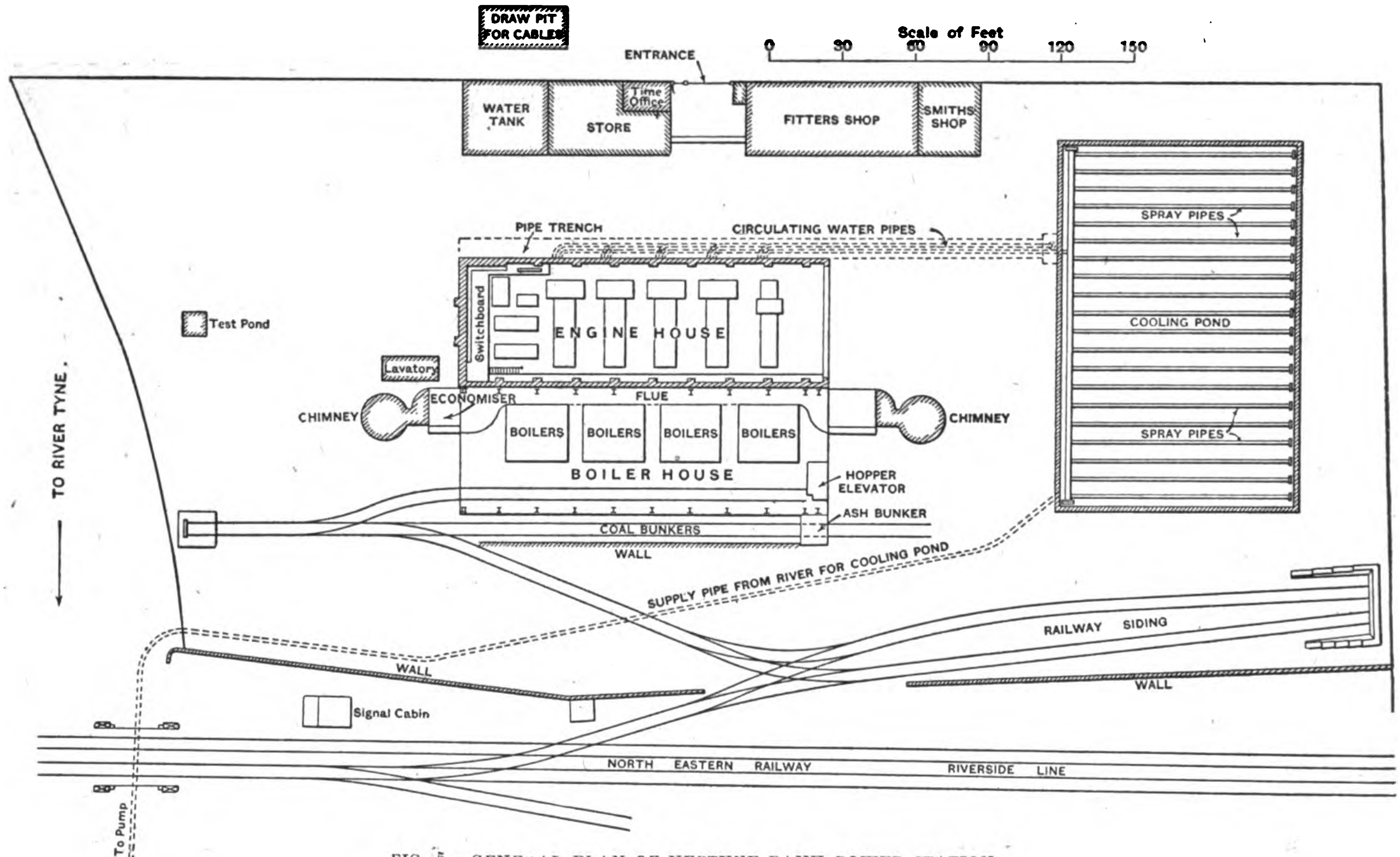


FIG. 5.—GENERAL PLAN OF NEPTUNE BANK POWER STATION.

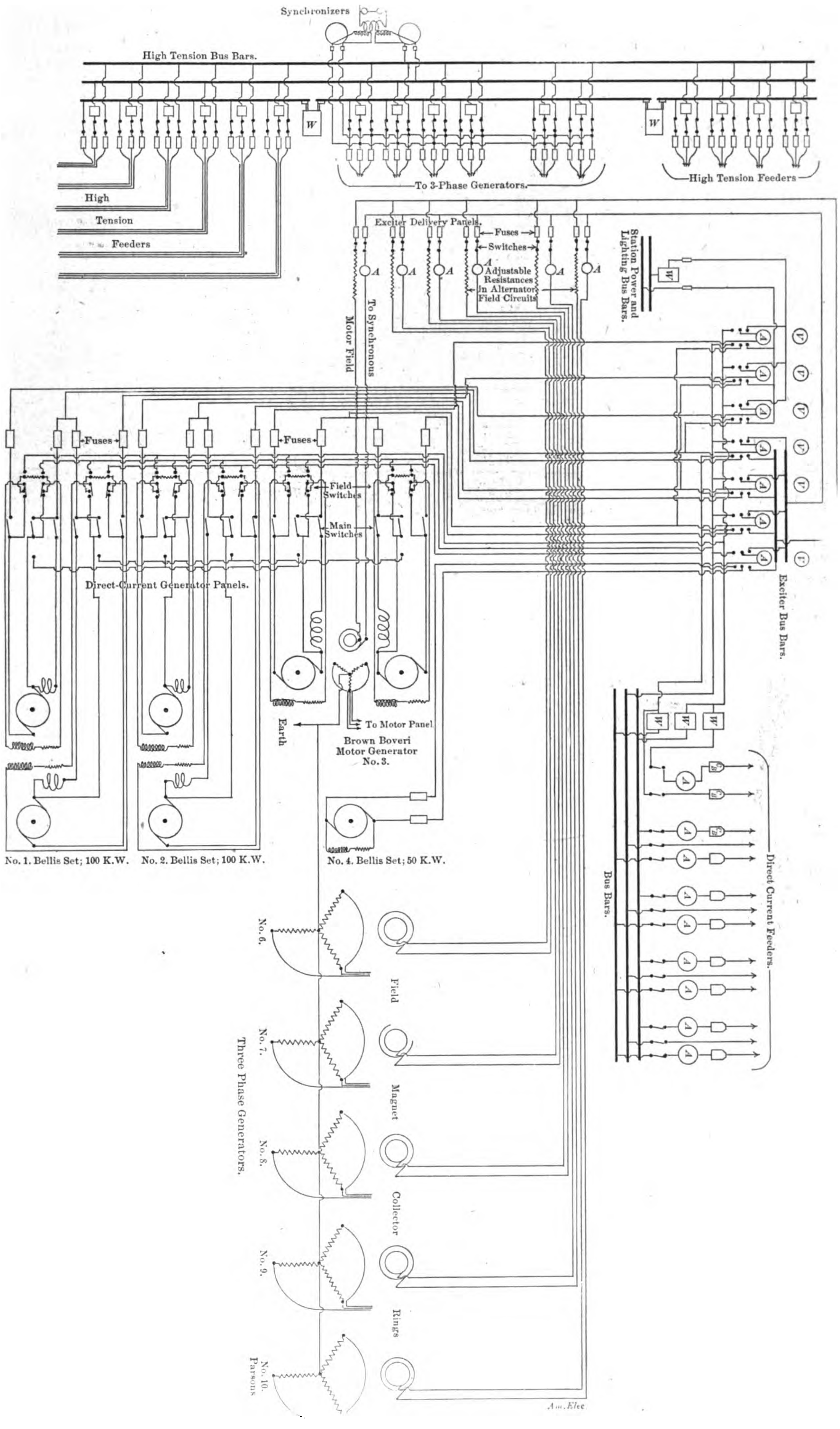


FIG. 6.—DIAGRAM OF SWITCHBOARD AND GENERATOR CIRCUITS AT THE NEPTUNE BANK POWER HOUSE.

A water rheostat, locally referred to as a "test pond," has been constructed outside the station for the testing of the various generators. The arrangement consists of a brick pit having three compartments containing water into which three plates of lead are immersed. Each plate is separately suspended from a rope passing over a pole carried on a wooden staging above the pit. Three windlasses are provided at a safe distance from the pit by means of which each plate can be raised and lowered independently, and thus the load can be readily balanced and adjusted. Overhead wires connect these plates with terminals fixed on the wall of the switchboard gallery, from which temporary connections may be made for testing any of the three-phase or direct-current generators. The rheostat is of sufficient capacity to absorb 1500 kilowatts at 5500 volts.

The station auxiliaries are motor-driven, as follows: Five centrifugal pumps, by motors of 20 horse-power each at 800 r. p. m.; four barring gear motors, of 6 horse-power each at 1000 r. p. m.; one air compressor, by a motor of 2 horse-power at 200 r. p. m.; vacuum pump, by a motor of ½ horse-power, at 600 r. p. m.; stoker gear, by a motor of 15 horse-power, at 900 r. p. m.; economizer gear, by a motor of 2 horse-power, at 700 r. p. m.; ash hoist, by a motor of 6 horse-power, at 600 r. p. m.; river pump, by a motor of 15 horse-power, at 350 to 700 r. p. m.; air pump, by a motor of 40 horse-power, at 100 r. p. m.

The high-tension cables supplying the gas company's territory are all of the three-core, paper-insulated, lead-covered type laid in solid iron troughs, the various troughs being bolted together. The low-tension direct-current cables are single core, insulated with vulcanized bitumen and laid solid in separate earthenware troughs covered with hard tiles, as indicated by Figs. 10 and 11.

The main transmission cables to Newcastle are also of the three-core type, each core having a sectional area of ¼ sq. in.; they are paper-insulated, lead-covered, and are, further, in the case of the Callender cables, surrounded with an armor of galvanized steel wire. The function of this covering is not, however, that of protecting the cable from mechanical injury, but it is put on in order to meet the Board of Trade requirement as to conductivity of earth sheathing. In the cables of the British Insulated Wire Company this requirement is met by providing just under the lead sheath a continuous layer of copper tape. The drawing-in system has been adopted for the transmission mains, the ducts consisting of 4-in. earthenware pipes. There

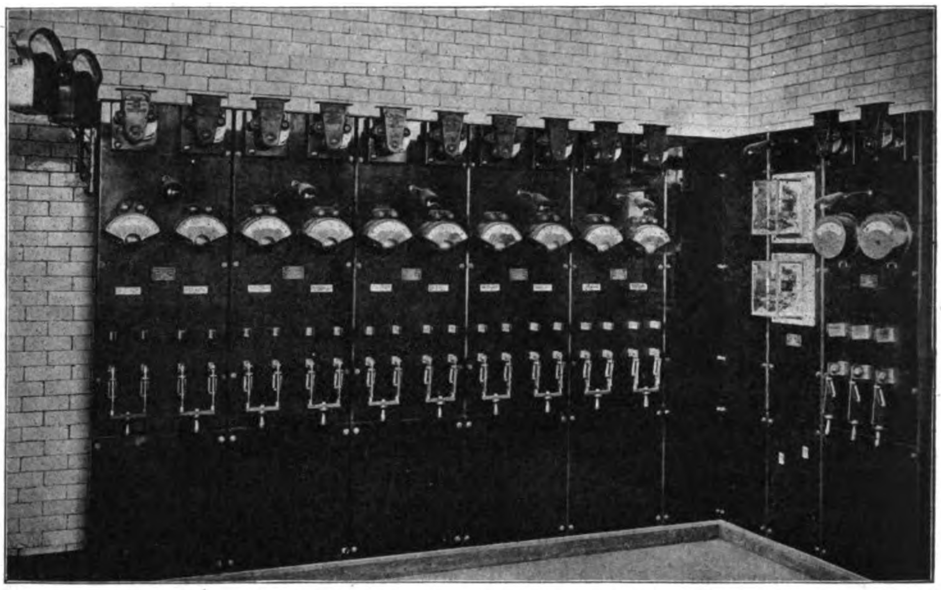


FIG. 8.—LOW-TENSION SWITCHBOARD.

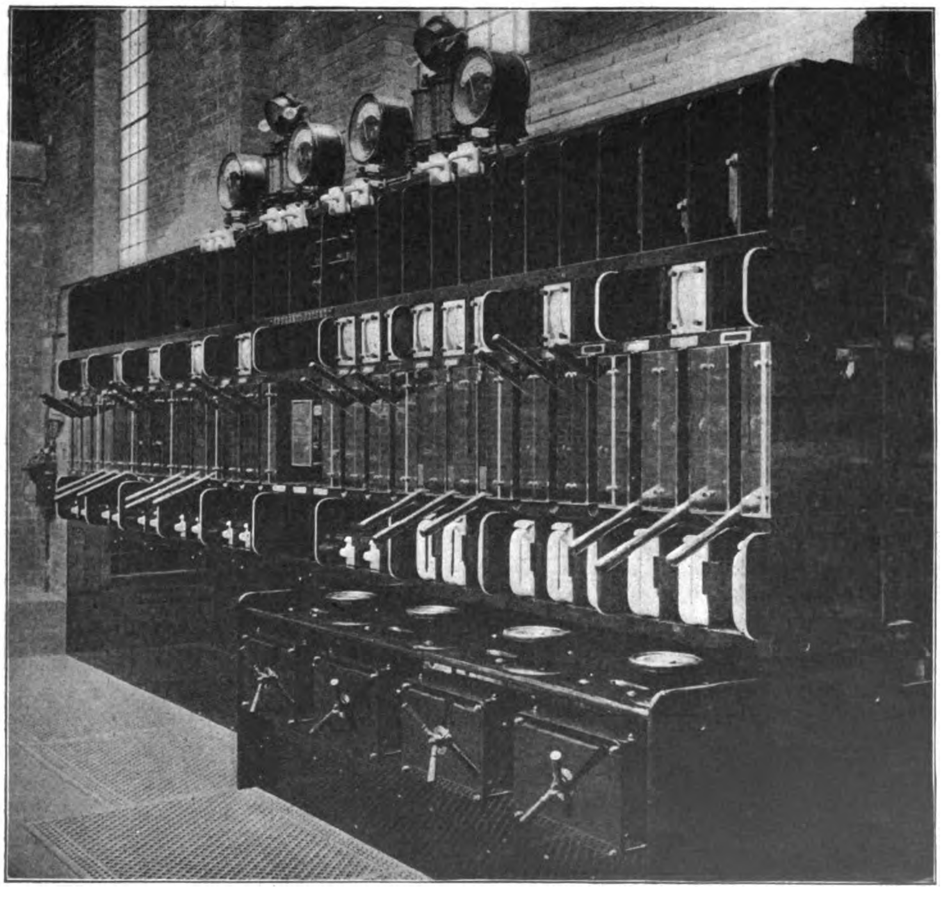


FIG. 7.—HIGH-TENSION THREE-PHASE MAIN SWITCHBOARD.

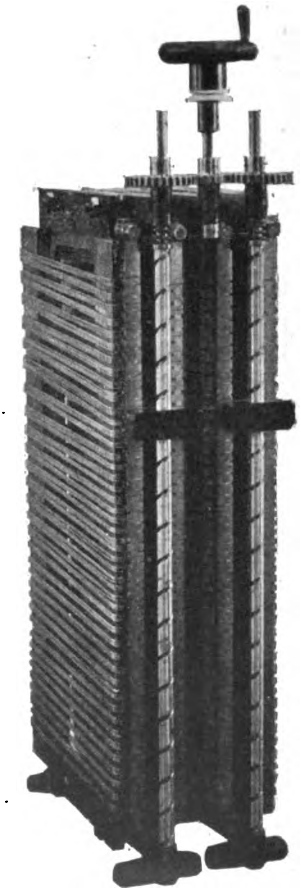
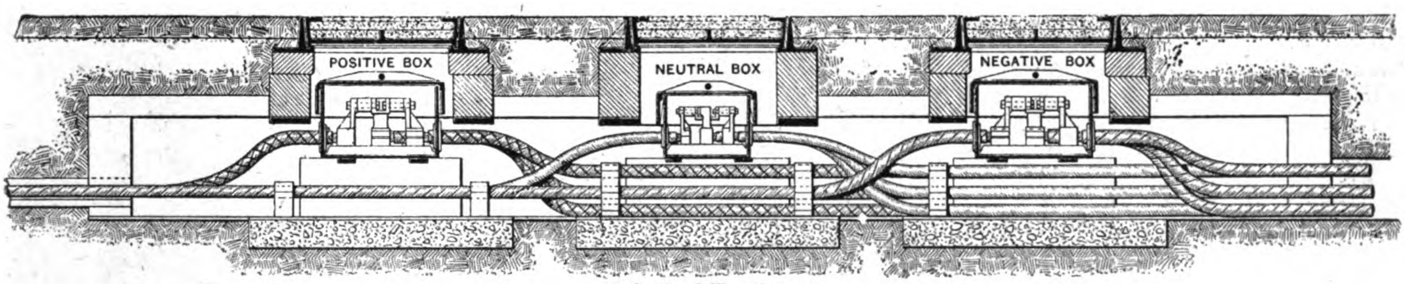


FIG. 9.—FIELD REGULATING RESISTANCE.

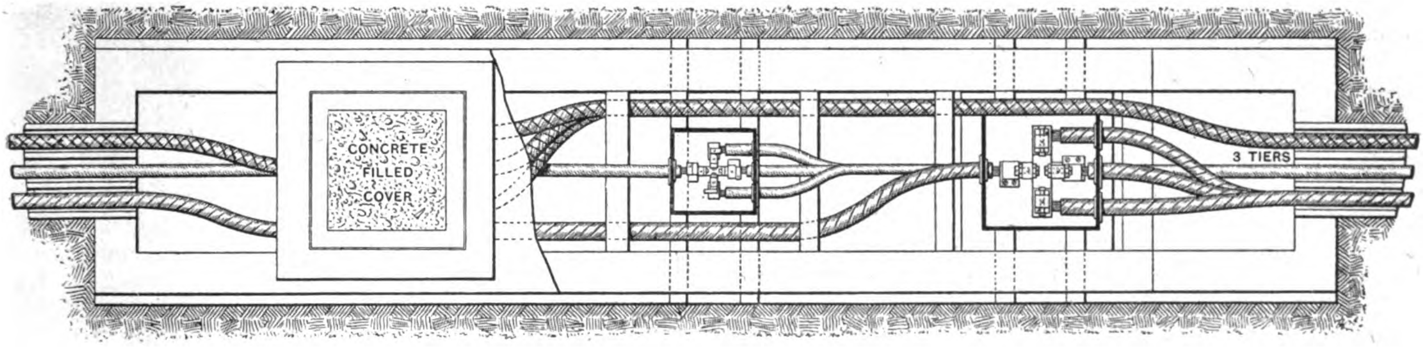
are nine of these pipes in each transmission route, laid in layers of three deep and embedded in concrete.

A separate cable will be carried up from Wallsend to the three main sub-stations, these sub-stations being interconnected on both their high-tension and low-tension sides; but while the low-tension interconnecting cable is only meant to be used on very light loads, the high-tension connecting cables are of the same section as are the main transmission cables from the generating station.

The three main sub-stations are practically identical in design, the only difference being in the length of the buildings, which was affected by the available site area. They are all designed for an eventual capacity of 2000 kilowatts in synchronous motor-generators. The equipment of each at present consists of two 500-kw. synchronous motor-generators, one 75-kw. synchronous balancing set, and one 25-kw. direct-current balancer.



Sectional Elevation.



Plan.

FIG. 10.—ARRANGEMENT OF FOUR-WAY BOXES FOR CABLES.

The 500-kw. motor-generators for the Newcastle sub-stations were built by Brown, Boveri & Co., of Baden; and two —the first installment for one of the sub-stations—by the BritishThomson-Houston Company, Ltd. Each set consists of one three-phase synchronous motor, wound for the line potential of 5500 volts, coupled to a single direct-current dynamo, the two machines being mounted on one bed-plate. The motor is of the revolving field type and the armature winding is star connected. The full load output of each direct-current set is 980 amperes at 510 volts, and the three-phase motor is so designed that by means of a field rheostat the power factor at full load can be varied from 1 to .80, the wattless component in the later case being a leading one.

No part of the apparatus except the commutators in continuous running at the full load rises in temperature more than 40° C., as measured by thermometer, and no part of the commutators rises in temperature more than 45° C. The motor-generators are capable of running for one hour at an overload of 25 per cent without excessive rise of temperature in any part or injurious sparking, the position of the direct-current brushes being fixed for all loads. The efficiency is guaranteed not to be less than 89 per cent at full load, 87 per cent at two-thirds load, and 78 per cent at one-third load.

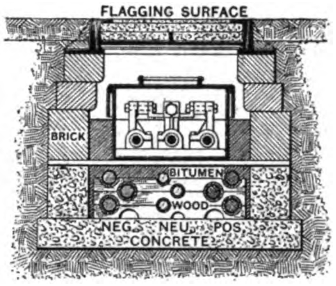


FIG. 11.—SECTION SHOWING CABLE BRIDGES.

The high-tension switchboard equipment at the sub-stations comprises a feeder board and a motor-generator board, which are placed at right angles to each other, and which are connected through a panel which contains wattmeters and power-factor indicators dealing with the total power being taken by the motor-generators. Each board is divided into two parts, a lower frame and an upper frame. The lower frame is located beneath the floor of the switchboard gallery and contains the high-tension bus-bars, switches, fuses and instrument transformers. The upper frame contains the rheostats, indicating instruments and handles for operating the main switches. The main switches are of the oil-break type, and are geared to the operating handles by means of chain and sprocket wheels. All the instruments, both voltmeters and ammeters, are operated through transformers. The whole of the high-tension parts are thus kept below the floor and rendered inaccessible to the operator on the gallery.

The low-tension switchboards at the sub-stations are divided into three parts, namely, positive, negative and neutral sections, which are separated by two voltmeter panels. There are three sets of horizontal bus-bars, and any generator, balancer or feeder can be connected to any of the three sets of bus-bars by means of the usual arrangement of vertical bars and screw plugs. The board is designed for ultimately dealing with four 500-kw. motor-generators, two balancers, and nine feeders, some of which will be interconnectors between sub-stations. For starting the synchronous motor-generators an arrangement of switches is provided by which any motor-generator can be connected with a special starting panel, which is fitted with starting resistances and an automatic cut-out, and is located at one end of the low-tension switchboard. The backs of the voltmeter switches are covered in with neat brass cases, and all voltmeter wires are run in metal tubing. The dynamo fuses and field switches are located on panels fixed on the wall that supports the switchboard gallery.

In addition to supplying manufacturers with power the companies have undertaken to install all apparatus which may be required for power or lighting purposes free of first cost to the consumer, charging a rental per annum based on the capital cost to the company of providing and installing the plant. For an additional sum per annum the companies undertake all the maintenance in connection with the installations, renewing of bearings, adjusting of brushes, trimming arc lamps, etc., and keeping the installation generally in good working order.

Owing to the great variety of the consumers' requirements which the plant is called upon to supply, difficulties have been encountered which have made it impossible to adopt one system of supply throughout, and have also rendered it difficult to standardize the apparatus used. Where the matter was left to the company's engineers, as is the case in most of the yards, they recommended the three-phase system, especially for all constant speed work; but as some of the manufacturers preferred direct-current, arrangements were made for supplying currents on either one or the other, or both, of these systems, as may be required.

On account of the quantity of direct-current required, and the fact that it is more suitable for arc lamps, direct-current distributing mains had to be laid throughout most of the district along the river side. This being so, it was convenient to do all lighting on this system and thus avoid the necessity of keeping the three-phase voltage constant to within 1 or 2 per cent; the direct-current is supplied from motor-generators.

As has been previously stated, alternating current is supplied at a pressure of 5500 volts, and for the purpose of reducing this to the working pressure of 440 volts a separate sub-station has been provided in such factories and works as are too far distant to take 440-volt current from one of the main sub-stations. The plant is now supplying power to a number of the largest shipyards and engineering works on the north side of the Tyne, in the majority of which three-phase currents are used. As practically the same arrangements have been carried out in the various yards in which the installation has been designed by the company's engineer, it will suffice, for the present purpose, to detail the arrangements in one yard, which may be taken as a typical example.

A large section of Sir W. G. Armstrong Whitworth & Co.'s Walker shipyard is now driven electrically, the total motor equipment at present aggregating some 400 horse-power. A transformer sub-station is located here, which contains the necessary transformers and switchboard panels. The high-tension switchboard, which is of Ferranti make, consists of two feeder and two three-phase transformer panels. Each feeder panel has been arranged for carrying 150 amperes per phase; an ammeter is provided in one leg only. The transformer panels stand at the right of the feeder panels, and the board is capable of extension in either direction without any alteration being made to the existing panels. The low-tension transformer and circuit panels are on the opposite side of the building. These carry each three fuses, one ammeter and one triple-pole switch. The yard is divided into various sections, each of which is controlled by a separate circuit panel in the sub-station.

Seven 50-kw. British Thomson-Houston single-phase transformers have been installed, six of which are in use, the seventh being kept in reserve. All the transformers are connected up delta so that the failure of one will not affect the supply.

The main cables leading from the sub-station are run overhead, each circuit terminating at a distributing board. All overhead lines are efficiently protected from lightning discharges by means of reactance coils and spark gaps. The standard distributing boards consist of cast-iron boxes of special design, equipped with the requisite number of panels. They are made in different sizes, suitable for taking from three to nine panels each, and are equipped with either power or lighting-circuit panels, according to the requirements of the case, the overall dimensions of the various classes of panels being identical. In order to guard against the risk of a short circuit in a power distributing box, *i. e.*, a box equipped with fuses of over 5 amperes capacity, single-pole boxes are used throughout. Wherever the cables strike down to a distributing box or motor they are run in iron pipe in order to protect them from mechanical injury.

The motors throughout this yard are of the induction type. Of the 29 motors which are installed 10 drive line shafting, the remainder driving individual machines. Three types of motor are used: one has a squirrel-cage rotor and the others are coil wound. For the purpose of starting the squirrel cage type of motor a compensator is employed in order to reduce the voltage at the stator terminals. Combined with these compensators is an oil break switch, so that in starting up a motor it is only necessary to actuate one handle. Owing to the possibility of placing this compensator at any distance from the motor this type has been used when the motors have had to be erected in out-of-the-way positions.

Of the other types of motor one carries a starting resistance mounted within the rotor itself. On starting up, this resistance is cut out by means of sliding contacts actuated by a handle through the hollow spindle of the motor, as shown in Fig. 12, while the others are provided with collector rings, and are used where variable speeds are required.

The maximum torque occurs at a point varying with different motors, but about 20 per cent below full speed. If the overload continues, the torque remaining the same, after the speed falls below the maximum torque point the motors containing resistances in the rotors cannot be started without adjusting the resistance; the squirrel-cage motors cannot be started at all, of course, until the torque is reduced below the maximum starting torque for that motor. If, however, after the load has caused the motor to "break down," the torque be reduced sufficiently rapidly as the speed falls, the motor will then pick up and come up to speed again. The drop at speed from full load is from 6 per cent for smaller sizes to 3 per cent for larger sizes. The maximum output is about twice the full load for 1, 2 and 3 h. p. motors, and from 2½ to 3 times full load for larger sizes.

The maximum starting torque of the squirrel-cage motors is 1½ times full load torque for the 1, 2 and 3 h. p. sizes, and from 1½ to 2 times full load torque for larger sizes. The maximum starting torque and current for the machines having resistance mounted in their rotors is from full load to 1¼ times full load torque and current. The motors having external starting resistances can be wound for starting torque of any value up to twice the full load torque.

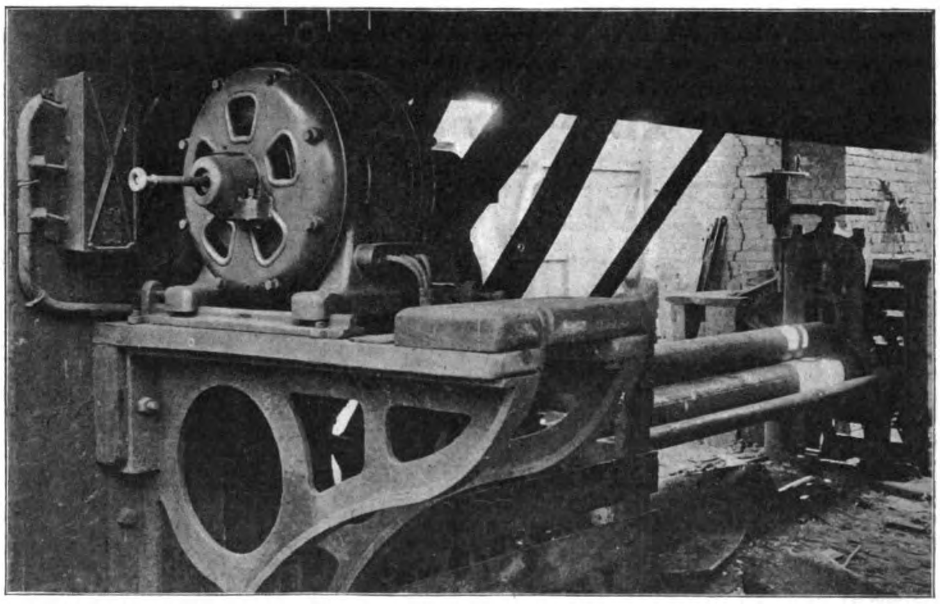


FIG. 12.—INDUCTION MOTOR WITH STARTING RESISTANCE IN ROTOR.

Mr. Charles H. Merz, who very kindly supplied the data for this article, is the consulting engineer for the plant, and Mr. H. L. Riseley is resident engineer and in charge of the station construction.

◆

Train Dispatching by Telephone.—It is reported that the Delaware & Lackawanna Railroad Company has taken steps to substitute the telephone for the telegraph in the work of train dispatching, with a view to shortening the time required for this work.

THE NEW BUFFALO TERMINAL TRANSFORMER STATION OF THE CATARACT POWER AND CONDUIT COMPANY.

BY FRED P. WOODBURY.

The new terminal transformer station of the Cataract Power and Conduit Company, located at the corner of Niagara and Ontario streets, Buffalo, N. Y., represents the most advanced engineering practice. The building is an unimposing one-story brick structure, about 30 x 70 ft. A traveling crane of 12 tons capacity spans the entire interior. There are seven transformers in the station, connected in two batteries of three each with one to spare for an emergency. The primary and secondary switchboards are similar in design; each has two sets of bus-bars, three transformers being connected to each set. The transformers, each of 2250 kilowatts capacity, are of the standard Westinghouse oil-insulated, water-cooled type. A coil of iron pipe is secured to the inner surface of the tank through which the water circulates. The station receives about 14,000 kilowatts over three three-phase transmission lines from the power-house at Niagara Falls, at an e.m.f. of 22,000 volts, and delivers it at 11,000 volts three-phase to the underground system of the city. Fig. 1 is a view of the transformer plant, and Fig. 2 is a general view showing the transformers on one side, the primary 22,000-volt switchboard in the background, and the secondary or 11,000-volt switchboard at the right, with the circuit-breakers in the gallery above.

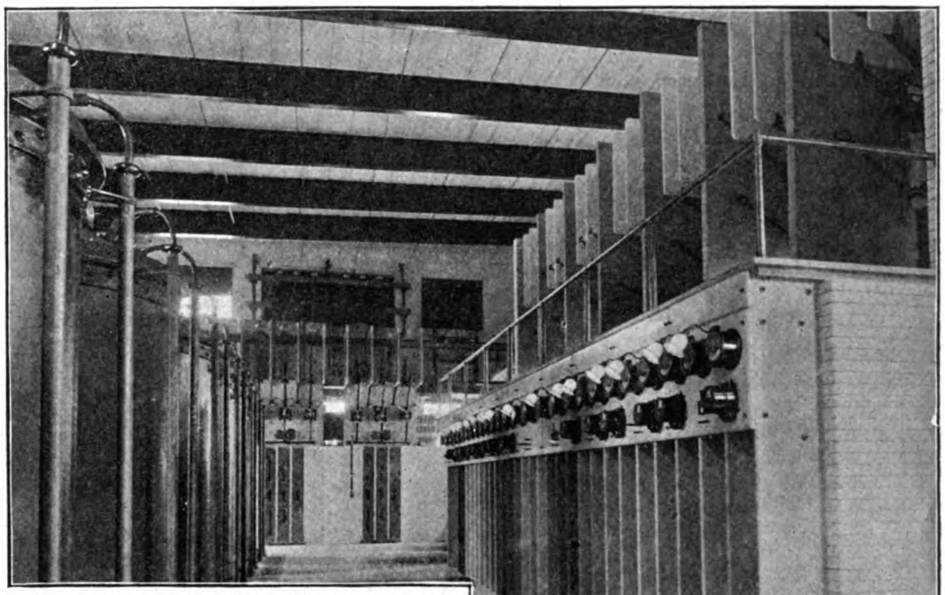


FIG. 2.—GENERAL VIEW OF STATION.

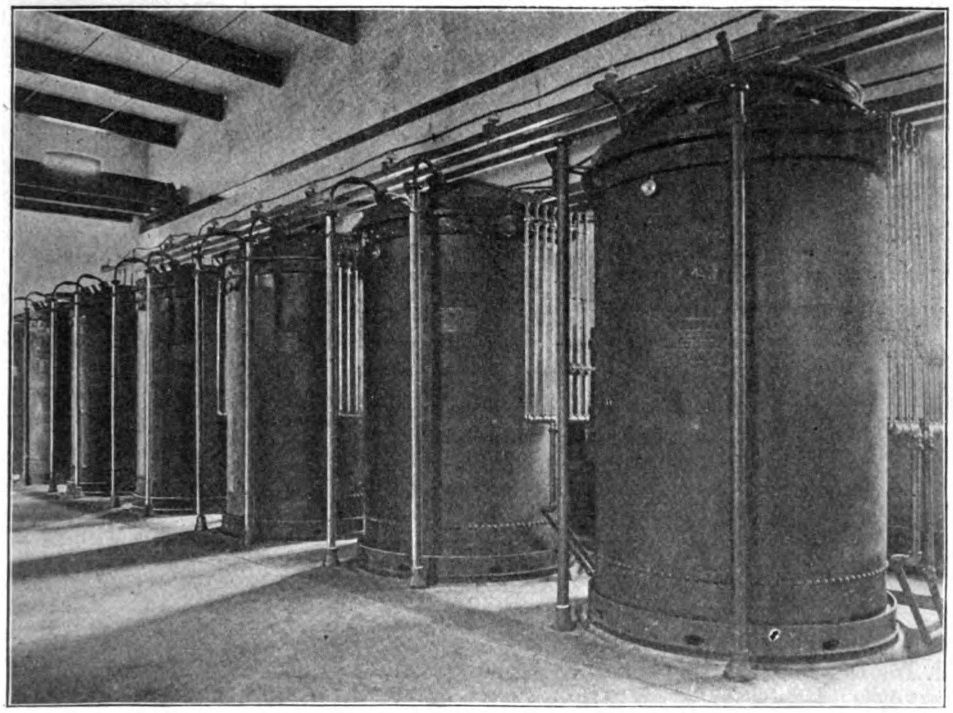


FIG. 1.—TRANSFORMERS IN NEW BUFFALO TERMINAL TRANSFORMER STATION.

Fig. 4 is a diagram of the switchboard connections. The three transmission lines of three conductors each enter the building at the southerly end just below the eaves. The spark-gaps and ground wires of the Wurtz lightning arresters are connected just inside the wall, about 15 ft. above the floor. Then the conductors lead to the circuit-breakers, which are specially designed for the high voltage and are located at the top of the switchboard panels. Directly below each circuit-breaker is a "selector" switch by means of which the current may be delivered to either or both sets of transformers. Fig. 3 is a section of the feeder panels on the secondary switchboard and shows the construction of the selector switches. Fig. 5 is an outline sketch showing face and side views of these switches. Each switch has two arms which when not in use are closed firmly upon themselves like pocket-knife blades, as seen in the left of the picture; this is in order to avoid the accidental closing of the switches. When the switch is to be used, one or both arms are swung through 180° and engage the contacts above and below. The switches are operated by means of a hook on the end of a long wooden pole which engages an eye in the end of the arm.

From the high-tension bus-bars the current passes through "static interrupters" to the transformers. The static interrupter is a combination of choke coil and condenser. The line is in series with the choke coil, and one end of the condenser is connected between the transformer to be protected and the choke coil. The other end of the condenser is connected to the ground through the fuse block shown at the right of the picture. Fig. 6 shows a static interrupter and Fig. 7 is a diagram

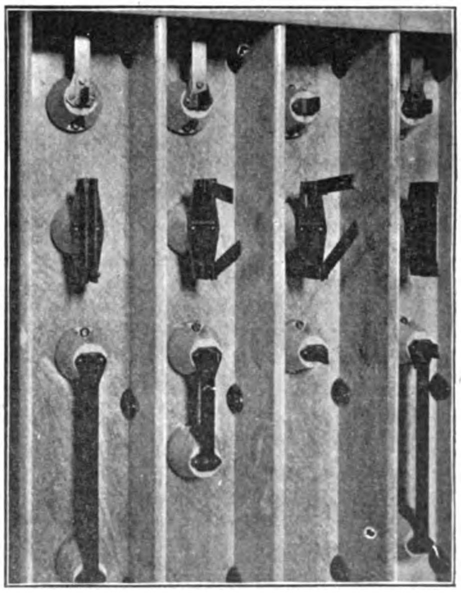


FIG. 3.—SELECTOR SWITCHES.

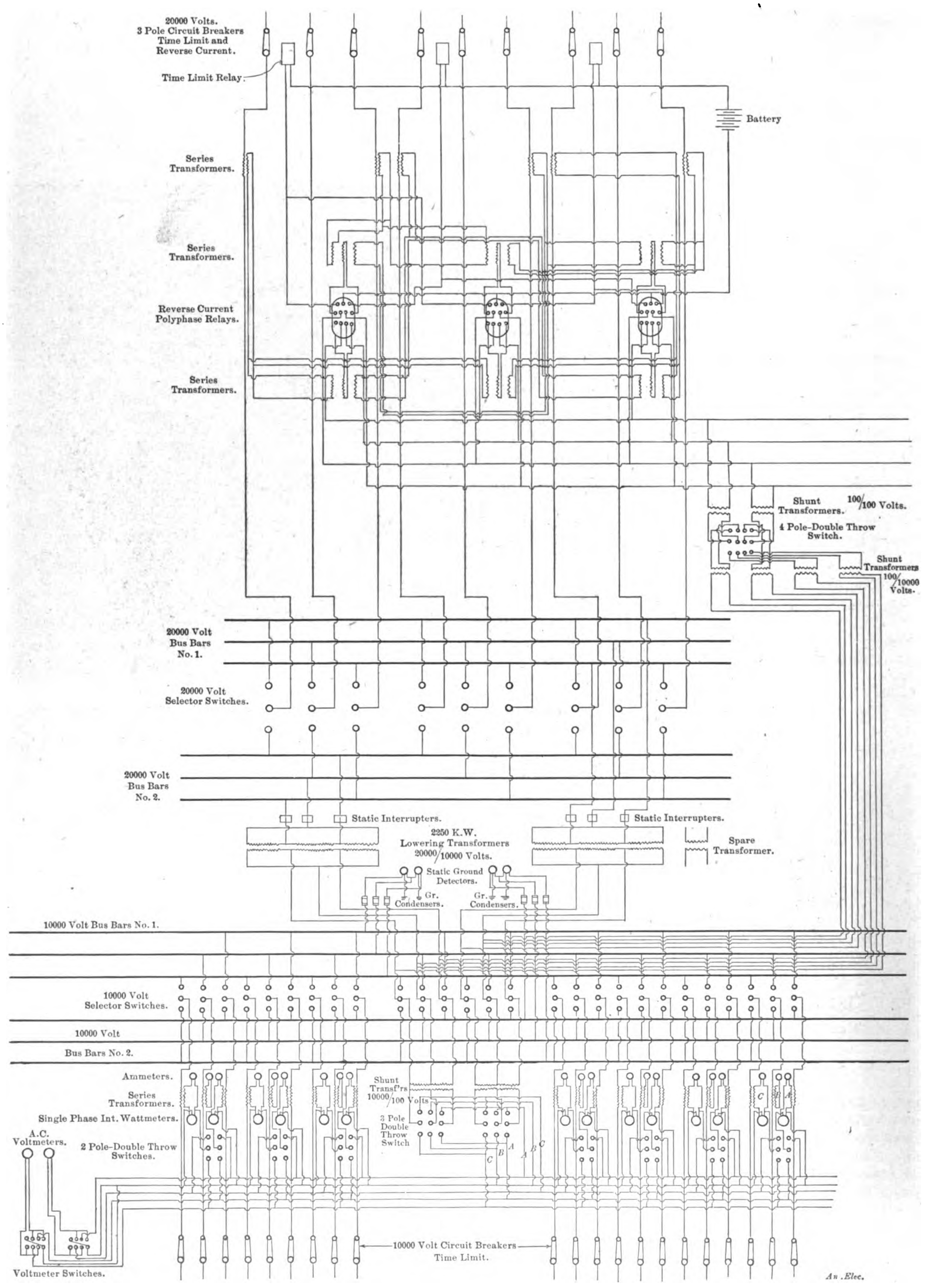


FIG. 4.—DIAGRAM OF SWITCHBOARD CONNECTIONS.

of the connections. The condenser and choke coil are immersed in oil. The fuse block is similar to those used on the voltmeter transformers.

At the secondary switchboard the transformer terminals lead to the two central panels; the power may be switched to the bus-bars by selector switches, as on the primary board. On the back of the board at the switch terminals are six condensers, one for each conductor, through which the ground detectors are connected, thus making it unnecessary to have metallic connection between the line and the ground detector. These detectors indicate the condition of the insulation of all the circuits in the station. From the secondary bus-bars the power passes to the feeders, seven in all. From the feeder switches the conductors pass through series transformers, for the instruments, to the circuit-breakers which are located in a gallery above the switch panels, and thence to the outside circuits, which are all underground except a temporary line to the Pan-American Exposition.

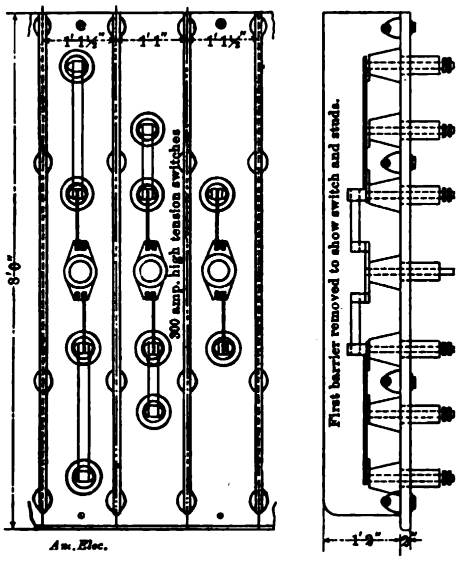

1'1⅛"
1'1"
1'1⅛"
8'0"
300 amp. high tension switches
First barrier removed to show switch and studs.
1'2"
2"
Am. Elec.

FIG 5.—FACE AND SIDE VIEW OF SWITCHES.

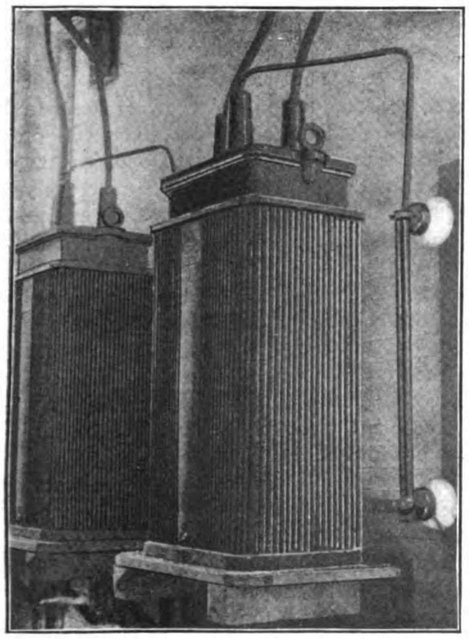


FIG. 6—STATIC INTERRUPTER.

All the instruments are located on the secondary switchboard. The two transformer panels contain two ground detectors each, and these are the only instruments on these panels. On each feeder panel there are three indicating ammeters and two recording wattmeters. The ammeters and series coils of the wattmeters are connected to the secondaries of the series transformers, which have a ratio of 300:5 amperes. There are two potential transformers of a ratio of 12,000:100 volts for each set of bus-bars. These transformers are supported upon a wooden frame back of the switchboard, and they deliver to the voltmeters and the potential coils of the wattmeters.

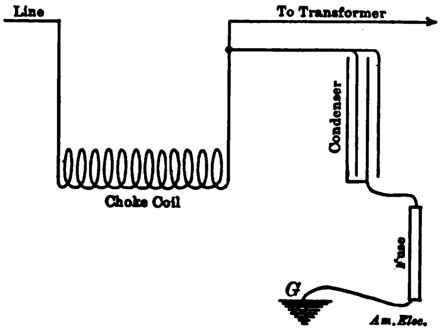


FIG. 7.—DIAGRAM OF CONNECTIONS.

On the end panel there is a voltmeter for each set of bus-bars, and there are, of course, the usual plugs and receptacles by means of which the instrument may be put across either leg of the circuit.

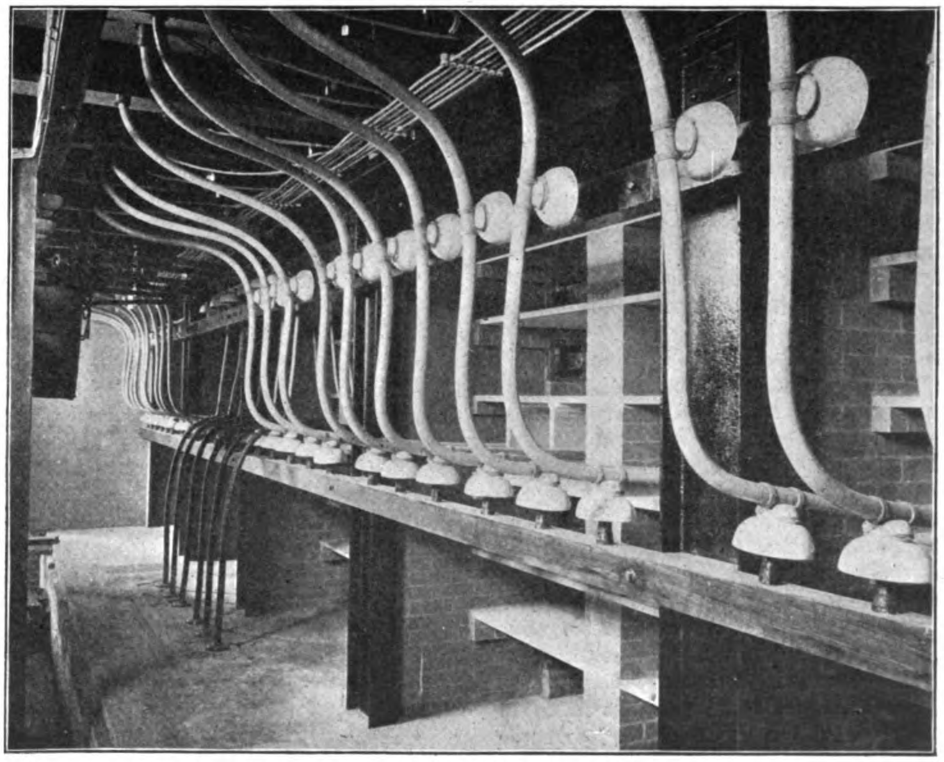


FIG. 8.—REAR OF SECONDARY SWITCHBOARD SHOWING CABLE CONNECTIONS

The fusible cut-outs for the voltmeter transformers are very simple in construction. Each fuse is enclosed in a 1-in. fiber tube about 3 ft. long, with walls about ¼ in. thick. A small hook is fitted in the side of the tube at each end, and a fine copper wire is drawn through the tube and secured by nuts on the shanks of the hooks. One end of the tube is closed with a heavy metal plug, and the tube is hung by the hooks in eyes at the end of the wire. The faces of the switchboards are of gray marble, supported by brick columns. Marble barriers separate the switches and are placed between the circuit-breakers. Studs and bus-bars are thoroughly protected by slate barriers on the back of the board.

The circuit-breakers for the feeder circuits are arranged in sets of three, each set being both tripped and restored together, so that in case of trouble all three conductors of the feeder will be opened simultaneously. Each set is fitted with a time-limit relay, comprising a clockwork mechanism which will not allow the circuit-breaker to open unless the overload continues for a predetermined time for which the relay is set. When the breaker is set to open at a certain current, should the line become loaded above this limit, the releasing trigger of the breaker is withdrawn and starts the time-limit relay, which locks the trigger before it has moved far enough to release the circuit-breaker. Should the overload continue to the expiration of the time for which the relay is set, the trigger is unlocked and the breaker opens; on the other hand, if the overload ceases before the time for which the relay is set has elapsed, the releasing trigger slips back into place and the relay resets itself.

The circuit-breakers on the primary board are similar to those on the feeders, but in addition they are provided with reverse-current relays. This attachment is desirable where two or more transmission lines are run in parallel; if a short-circuit occurs on one of the lines the parallel lines will tend to feed back through the sub-station and the circuit-breakers on the defective line will be promptly opened. The relay is built on the principle of a wattmeter. The potential coil is excited from an outside but constant source. The series coil is in series with the secondary of a series transformer whose primary is in the line. Should power be forced backward through the circuit-breaker from some other line, the reverse-current relay will connect a battery to the time-limit relay, and if the reversal of power continues beyond the period of time-limit, the circuit-breaker will be opened through the time-limit relay, as in the case of an ordinary overload.

Fig. 8 is a view behind the secondary switchboard, showing some of the cable connections. These are mounted on porcelain insulators, as are all of the conductors throughout the station.

The plant is entirely Westinghouse in design and construction, and under the management of Mr. L. E. Imlay, the company's engineer, who kindly supplied the illustrative material for this article. Mr. Imlay, assisted by Mr. James R. Newell, has brought the installation to completion within the last few months.

◆

BOILER ROOM EFFICIENCIES.

BY WILLIAM D. ENNIS, M. E.

Broadly speaking, the steam plant consists of furnace, boiler, engine, condenser, feed pump and heater; the heating medium in the last-named being exhaust steam or waste flue gases. Certain elementary figures with regard to the performance of the various units should be constantly in the mind of every engineer. The starting point is the furnace. This is scientifically a separate element from the boiler proper, but the two are generally spoken of as one under the comprehensive term "boiler." In this latter sense the boiler consumes coal and makes steam. In a proper sense, the furnace consumes coal, producing heat; the boiler consumes heat, producing steam.

The effectiveness of the furnace is equal to the heating value of the coal, minus the heat lost by failure to burn some of the coal, the heat lost by failure to completely consume the remainder of the coal, and the heat lost by radiation. The first loss is indicated by particles of coal in the ash; the second is indicated by smoke in the flue gases and may be measured by an analysis of flue gases. The effectiveness of the boiler is equal to the heat supplied from the furnace, minus the heat lost by radiation or in the construction of the boiler, and the heat lost in the escaping flue gases. This last loss can be measured by ascertaining the temperature in the flue.

What is the normal amount of these losses? The entire boiler and furnace structure has, under exceptional conditions, shown an efficiency of over 80 per cent; that is, 80 per cent of the total heating value of the coal has been converted into steam. When the indirectness of the process is considered, this is an extremely high figure, especially as compared with the economy of an apparently simple mechanism like the steam engine, in which from 5 to 15 per cent only of the heat in the steam is converted into useful work.

The loss by radiation cannot be determined directly, nor can it be separated between boiler proper and furnace. It can be computed for the entire structure by ascertaining the total efficiency and the other losses, and subtracting their sum from a figure indicating perfect performance.

The starting point is to determine the heating value of the coal. This may be done by chemical analysis or by calorimetric determination in the laboratory. The latter method is more reliable. Most common coals have a well-known calorific, or heating value which can be ascertained as a basis for calculation. It must be corrected, however, if exceptional variations in the percentage of moisture or incombustible matter occur.

The loss by unburned coal in the ash can be determined by a calorimetric test or chemical analysis of the latter, or by picking out the particles of a fine coal and comparing their weight with that of the total ash.

The solid coal lost as smoke forms a heavy item of loss, and one that is difficult to compute. A system of charts is sometimes used, by which the percentage of carbon thus lost is determined from the shade of the smoke. A soot catcher will give reliable results if the air supply can be measured. The coal analysis and measurements of the air supply and of the temperature of the flue gases will enable the observer to compute the weight of flue gases; and the soot can be analyzed and weighed if desired. A properly-constructed furnace and a suitable method of firing will reduce this loss to a minimum.

The amount of heat lost by incomplete combustion can be calculated by flue gas analysis ascertaining the percentage of carbon monoxide. The heat lost in the flue gases can be determined by noting the temperature. If the heat units in the coal be represented by C, the final efficiency of the entire boiler by B, the heat lost by radiation by x, the loss by unburnt coal in the ash by D, that by unburnt coal as smoke by E, that by the formation of carbon monoxide as F, and that by the high temperature of the flue gases by G, the following formula will hold:

$$C = BC + D + E + F + G + x,$$

or,

$$x = C - BC - D - E - F - G.$$

The only unknown quantity in the right-hand side is B, which may be determined from the equation

$$B = (H - h)\ Q \div C,$$

in which H represents the total heat in one pound of the steam at the actual pressure (from steam table); h, the total heat in one pound of the feed water at the actual temperature (practically equal to temperature — 32); and Q, the number of pounds of steam produced. The formula for the value of x then becomes:

$$C - (H - h)\ Q - D - E - F - G$$
$$= C - HQ + hQ - D - E - F - G.$$

The value of Q is, of course, determined by measuring the feed water for a given period of time. $D = sw = Cw'$; in which s represents the heating value of one pound of ash; w, the number of pounds of ash formed; and w', the pounds of unconsumed coal found mingled with the ashes.

$E = s'w''$, in which s' is the heating value of one pound of the solid matter contained in the flue gases (approximately equal to C for one pound weight) and w'' is the weight of such solid matter.

$F = 1000 \dfrac{P\ N}{C}$, approximately, in which P is the percentage, by weight, of carbon monoxide in the flue gases; and N, the number of pounds of coal burned.

$G = (t - t')\ r\ Q'$ in which t represents the temperature of flue gases; t', the temperature of steam in boiler (from steam table); r, the specific heat of flue gases (about .55), and Q', the number of pounds of flue gases produced (usually about 25 lbs. per pound of coal, with natural draft).

Good coal contains from 10,000 to 14,000 heat units per pound, and in a properly-designed boiler will evaporate from 7 to 11 times its weight of water. Even a very fine coal, if carefully fired, will not lose more than 1 per cent in the ash pit. The flue gases, where hand firing and natural draft are used, are ordinarily at a temperature of from 500° to 600°, unless cooled by an economizer, in which case they will range from 325° to 525°. Suppose these values to be true of a given boiler plant. A manufacturer of furnaces proposes to install his furnace and claims that he will be able to save 25 per cent of the fuel. What can the furnace do but decrease the losses by unburned coal in the ash or smoke, or by the formation of carbon monoxide? If the proposed furnace should reduce these losses absolutely to zero, the saving would be only about 4 per cent in an ordinary case. Or suppose a flue gas heater is suggested and a saving of 20 per cent guaranteed. Assume that the temperature of the gases is 575°, that of the feed water 182° and that of the steam in the boiler 338°. The limit of saving reached is when the gases are cooled or the water heated to the last named temperature. But the specific heat of the gases is 0.55, and that of the water 1.00. The heat lost by the gases in cooling to any definite temperature, say tx, would be $125{,}000 \times .55 \times (575 - tx) = 39{,}531{,}250 - 68{,}750\ tx$. The heat gained by the water up to the same temperature would be $40{,}000\ (tx - 182) = 40{,}000\ tx - 7{,}280{,}000$. The two quantities of heat would be equal, and $39{,}531{,}250 - 68{,}750\ tx = 40{,}000\ tx - 7{,}280{,}000$; or, $108{,}750\ tx = 46{,}811{,}250$, and $tx = 430°$.

This would heat the water higher than the temperature of the steam in the boiler, which would be an embarrassment of riches. The limit would therefore be reached long before the entire amount of heat wasted in the gases had been reclaimed. This would be true in any case, as it is in practice impossible to cool the flue gases to within about 100° of the temperature of the water on account of the extremely slow rate of transmission of heat at so slight a difference of temperature. The total waste in the flue gases is only 24 per cent; and the total possible cooling required to raise the feed water to 338° is only 91° or 38 per cent of the difference in temperature between the gases and the steam; so that the highest possible benefit from the economizer would be $0.38 \times 24 = 9$ per cent gain in efficiency. Another way of figuring it would be to take the number of degrees the water is heated and divide by 10 to obtain the percentage of gain. This is only 15½ per cent. In actual practice the gain is much less than this, for the reason above mentioned; to say nothing of the power necessary to drive the draft fan that would be necessary to burn the fuel with economizer tubes restricting the free exit of the hot gases.

The actual practicable efficiencies in connection with the parts of the boiler structure are as follows: A good furnace will utilize from 80 to 95 per cent of the heat in the fuel. The boiler proper will transmit to the steam from 50 to 85 per cent of the heat due to combustion. The point of efficiency is therefore from 40 to 81 per cent. Improved furnaces, at the very best, could save only 20 per cent. Economizers, feed-water heaters, water tubes, special settings and the like, only 50 per cent, and in most cases not more than 30 per cent.

The practicable saving by the use of an economizer is expressed by the foregoing formulas. That by exhaust steam heaters may be arrived at as follows: Steam engines, simple, non-condensing, will consume an average of 30 lbs. of steam per indicated horse-power per hour. Compound condensing engines average from 15 to 20 lbs. The most economical engines built seldom get below 13½ lbs. in actual practice.

Steam piping, considered as an apparatus, is of variable efficiency, depending upon the design and the amount and nature of the load. In a modern central station where all condensation is economically disposed of, the loss may be as low as 1 per cent. In a good power plant it is at least 5 per cent, and in many manufacturing establishments, where the steam power is a side issue, it ranges from 10 to 50 per cent.

The effect of exhaust steam feed-water heaters depends upon the amounts and pressures of steam and water, and the design of the heater. The heating is due to the condensation of the steam (or a portion of it), and consequently depends upon the latent heat. At the same time, it must be remembered that the water cannot be heated to a higher temperature than that of the steam. In practice it is never heated quite to the temperature of the steam, the rate of transmission at slight differences of temperature being so small that the water has left the heater before an interchange of heat can take place. With perfect transmission the final temperature of the feed-water would be approximately

$$x = \frac{L\,Q'}{Q} + t,$$

in which t represents the temperature of feed water at the entrance to the heater; Q, the pounds of feed water passing through the heater in a given time; Q', the pounds of exhaust steam supplied during the same time, and L, the latent heat of 1 lb. of the steam; the steam being dry, or at the tabular temperature corresponding to its pressure. The limiting value of x is reached when it equals the temperature corresponding to the pressure of the exhaust steam. The amount of steam required to heat a given amount of water would be $Q' = \frac{Q\,(x - t)}{L}$. For an ordinary power plant, assume that $Q = 2000$; $x = 212°$; $t = 60°$, and $L = 966$. Then $Q' = 315$ lbs., so that less than one-third of the amount of steam generated would be required to heat the feed water to the temperature of the steam after it has passed through the engine.

How shall the surplus exhaust steam be disposed of? The usual method is by condensation. This, however, reduces its pressure below that of the atmosphere, so that the highest temperature possible becomes from 120° to 160°, depending upon the amount of vacuum.

Such a temperature of boiler feed water is not altogether satisfactory and leads to the use of flue gas heaters, commonly called economizers. If surface condensers are used, no heater is necessary in the exhaust pipe line, the condensed steam being taken from the hot well and passed through the economizer. This requires the use of a grease separator on the exhaust pipe in order to prevent cylinder oil from reaching the boilers. There is no oil separator on the market which has been universally satisfactory. The circulating water from a surface condenser, or the mingled condensation and discharge water from a jet condenser, can be used as primary sources of supply for boiler feeding if desired.

In general, the final temperature of the feed water after passing through an exhaust steam heater is from 10° to 30° below that of the steam. In an economizer the usual difference between gas and water temperatures is about 100°. The highest economical feed temperature that is practically available is then about 300°, if the initial flue gas temperature is 550°, and even this is rarely attained.

There is no method known of securing a further decrease in the waste due to the high temperature of escaping flue gases. The only other opportunities for saving lie in a perfect system of reclaiming the steam wasted. This may be summarized as follows:

1. Thoroughly protect the pipe lines from the boilers to the engines.
2. Use the most economical engines, adapting the capacity to the load.
3. Condense surplus exhaust steam.
4. Reclaim all drips, condensation and condenser discharge water, taking all possible precautions to keep cylinder oil back.
5. Pass the lukewarm feed water thus obtained through an auxiliary heater, receiving pump and condenser exhausts approximately at atmospheric pressure.
6. From the auxiliary heater, pump the feed water through an economizer to the boilers.

The third stipulation may require some explanation. How can the exhaust steam be used in manufacturing processes or for domestic purposes, and at the same time condensed? There are two ways of obtaining this result. Where a plant consists of a number of engine units, some may exhaust at back pressure and some may be run condensing. The engines which should run condensing are, usually, those which are overloaded, are operated at the highest initial pressure, are compounds, or are least economical. If all the exhaust steam available is from a single engine the problem is somewhat more complicated. By carefully adjusting the valves, the engine may be set to have one side exhaust into vacuum and the other into back pressure; or an automatic valve can be placed on the main exhaust so adjusted as to maintain a constant pressure on the heating line and pass the surplus exhaust steam to the condenser; or the back pressure line may have a relief valve venting into the condenser.

If hot water is required for domestic or manufacturing purposes, the exhaust can pass through a feed-water heater and then to the hot-water tank, the supply of steam for heating being taken from a tee on the main line. It will be difficult in this case to maintain an effective circulation through the mains and coils. Another way of securing hot water is from an economizer. The primary source of supply, for this as for the boiler feed, can be from the hot well, receiving drips, overflows and make-up water.

In these suggested processes of economizing steam production, the proposed undertaking must be calculated down into heat units, with a debit and credit side, the balance, whether favorable, or unfavorable, being entered to the steam plant. Good theory in this cannot go far wrong. "Main strength and awkwardness" will count for little in cases where the best scientific judgment must often work with extreme care. It is mistaken policy to depend upon any manufacturer's guarantee, for in many cases the combined efforts of the best lawyer, engineer and business man would be inadequate to formulate a guarantee that would be conclusive, satisfactory and binding. The engineer must know his ground and take some of the responsibility himself, holding the manufacturer of apparatus responsible not for the behavior of steam and water, which is beyond his control, but merely for intelligent design and arrangement to such an extent that in actual practice some approach may be made to the economies shown possible by sound theory.

American Engines for the Glasgow Tramways.

The conspicuous success that has been achieved in the British field by American engine builders has been so often and so comprehensively discussed in the columns of the technical press that there is practically nothing more to be said on that subject. Among the engines that have gone to Great Britain from this country several have been of especial interest in point of design and magnitude of output. The Allis engine illustrated herewith may properly be included in this class. This is one of two engines that were built for the Glasgow Corporation Tramways—the municipal street railway system of the city of Glasgow, Scotland.

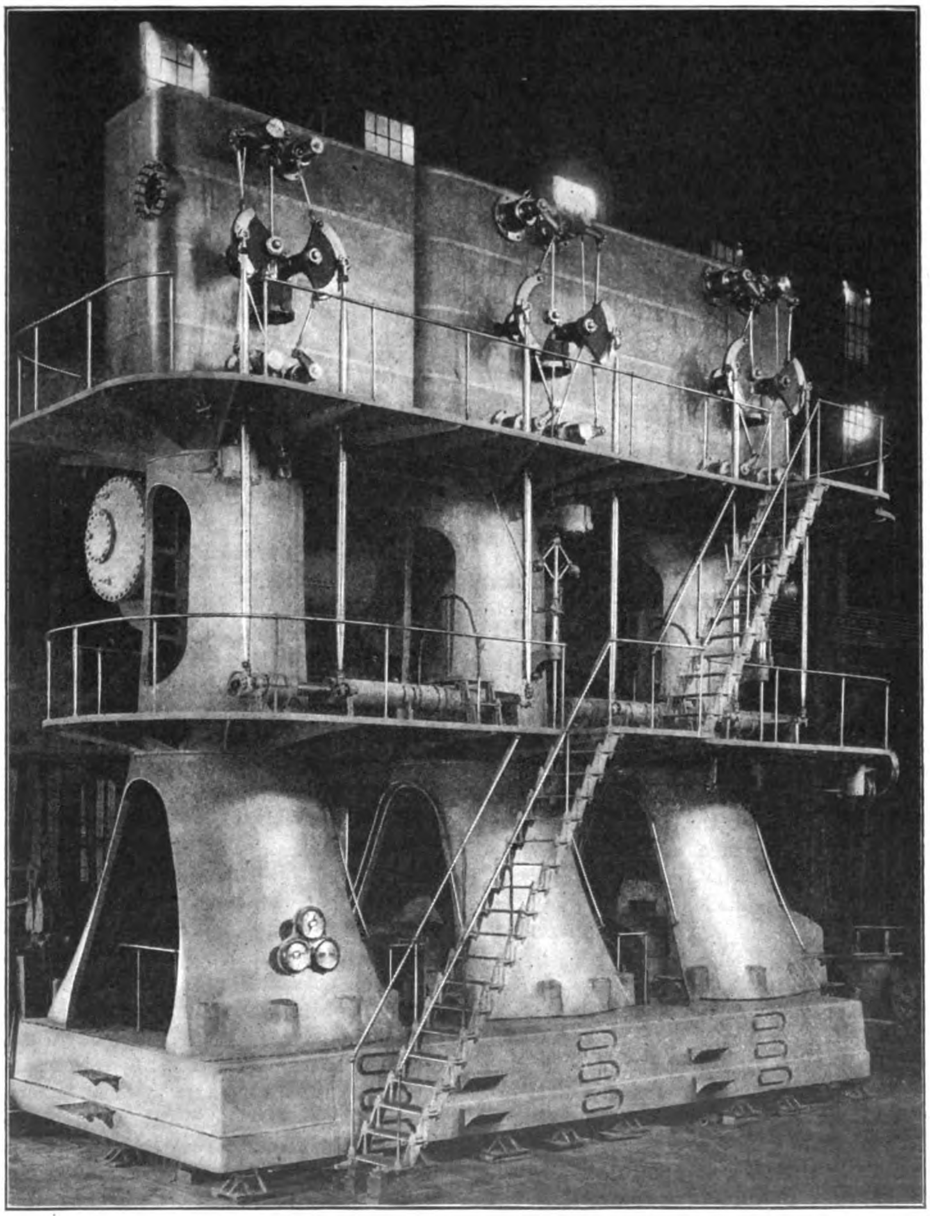


FIG. 1.—ONE OF THE 4000 HORSE-POWER ALLIS ENGINES INSTALLED AT GLASGOW.

The engine is a three-cylinder compound, having a high-pressure cylinder 42 ins. in diameter and two low-pressure cylinders each 62 ins. in diameter, the common stroke being 60 ins.; the cylinder ratio is therefore 4.36, scant. The high-pressure cylinder is steam jacketed and its exhaust is delivered to a reheating receiver mounted alongside the middle of the engine frame immediately below the upper gallery. The valves, both steam and exhaust, are located in the heads of all three cylinders. The valve-gear is of the familiar type employed by Mr. Reynolds on vertical engines, the steam and exhaust valves being operated by separate segmental wrist-plates. The rock-shafts intermediate between the eccentric rods and the wrist-plate rods (which would be the hook rods on a horizontal engine) are located on the floor of the lower gallery and the dash-pots are located immediately beneath the upper gallery. The engraving shows the gear so clearly that a detailed description is superfluous.

The photograph from which this engraving was made was taken while the engine was on the erecting-room floor and before the shaft had been put in place. The shaft is hollow, 32 ins. in diameter within the bearings and 36 ins. in diameter within the fly-wheel and the revolving member of the generator which the engine is to drive. The part of the shaft that carries the fly-wheel and generator overhangs the engine bed and is supported by an extreme outboard bearing. The main bearings are 32 ins. bore and 64 ins. long, and are water-jacketed. The fly-wheel is 24 ft. in diameter and weighs 120 tons. The engine runs normally at 75 r.p.m. (giving a piston speed of 750 ft.), and is rated at 4000 horse-power at maximum economy, the normal load being put at 5000 horse-power.

◆

THE PRACTICAL APPLICATION OF SUPERHEATED STEAM.

BY GEO. A. HUTCHINSON.

A dry and saturated vapor, not in contact with the liquid from which it is formed, may be heated to a temperature greater than that corresponding to the given pressure for the same vapor when saturated; such a vapor is said to be superheated.* The equation for superheated steam is $pv = 93.5T - 971 \sqrt{p}$, in which p is the absolute pressure in pounds per square foot, v is the volume in cubic feet, and T is the absolute temperature in degrees. Fahr. Saturated steam at 150 lbs. boiler pressure has a temperature of 365.7° Fahr. If a pound be superheated to 600°, the volume remaining constant, or about 2.756 cu. ft., according to the above equation, the pressure will become about 202 lbs. One pound of saturated steam at the same temperature would probably develop a pressure exceeding 1500 lbs. per square inch. If, however, as is the case through expansion, the pressure of the superheated steam remains practically constant and the volume increases, 1 lb. will have a volume of 3.674 cu. ft., instead of 2.756 cu. ft. With a feed water temperature of 100°, 1125.5 British thermal units must be added to 1 lb. to evaporate it at 150 lbs. pressure. A further addition of 112.6 British thermal units will superheat it to 600°, and increase the volume from 2.756 cu. ft. to 3.674 cu. ft. In other words, 10 per cent additional heat increases the volume of the steam $33^1/_3$ per cent.

The relations may be exemplified by a consideration of the diagram, Fig. 1. Suppose that a given weight of saturated steam has the volume ag, and that an equal weight of superheated steam has the volume ab. If the saturated steam expands adiabatically in a non-conducting cylinder—that is, the intrinsic energy of the steam is turned into work without loss or gain of heat—the exponential curve *gh* ($pv^{1.135}$ = a constant) will present, approximately, the process, and the area *aghif* the work done. The steam loses heat, and a portion condenses during the process, as may be seen by comparing the lines *gc* and *gh*, *gc* being the curve of saturated steam, which follows approximately the relation $pv^{1.0646} = k$. If the superheated steam expanded adiabatically the curve *bc* would be plotted from the relation $pv^{1.333}$ = a constant. At *c* the point of saturation would be reached, and from then on condensation would ensue, and the curve *cd* ($pv^{1.135}$ = a constant) would represent the process thereafter. The work performed would be represented by the area *abdef*, and the gain due to superheating by the portion which is cross hatched.

---

*Peabody's "Thermodynamics of the Steam Engine."

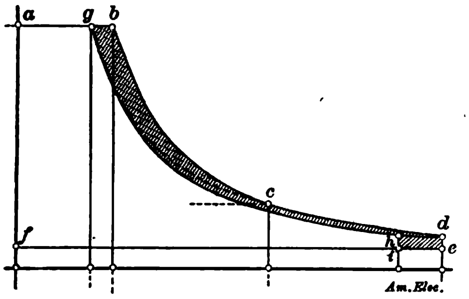


FIG. 1.—ADIABATIC EXPANSION CURVES.

As superheated steam is more nearly in the condition of a perfect gas, its specific heat is low, and the superheat is soon lost during expansion. To illustrate, the specific heat at constant pressure of saturated steam is given by Prof. Peabody for the following absolute pressures:

Pressure in pounds per square inch.	5	50	100	200	300
Temperature, t° Fahr.	162.3	280.9	327.6	381.7	417.4
Specific heat..	1.607	1.237	1.122	1.001	0.931

For superheated steam the specific heat at constant pressure is about 0.4805, and for air it is 0.2375.

There is always a loss by radiation in the steam pipes and passages, as well as a loss due to clearance and to the heat absorption by the cylinder walls, which are exposed periodically to the low temperature of the exhaust. The advantage of superheated steam may be attributed to three considerations; at high temperature it behaves like a gas, and a considerable amount of heat may be abstracted before any portion will liquefy; a moderate addition of heat produces a proportionately large increase in volume and diminishes the weight of steam used per stroke for a given amount of work; it has a greatly reduced thermal conductivity as compared with saturated steam, and therefore the heat absorbed by the cylinder walls becomes a fraction only of what it would otherwise be.

To gain any advantage from the increase of volume the superheating should be carried to the highest degree practicable. Experience has shown that the steam should be heated 125° to 175° above the saturation temperature in order to prevent condensation before cut-off. Even in a non-conducting cylinder it would be impossible, with a high initial pressure, to preserve the steam in a superheated condition until the end of expansion. With lower pressures, an initial temperature of 650° is necessary in order, even theoretically, to permit of superheat in the exhaust. In an engine as actually constructed there are many disturbing elements. From one-quarter to one-half of the so-called dry steam entering the cylinder is condensed during admission, and the most of it goes out of the exhaust port without having performed any work. Under the best conditions an initial condensation of at least 20 per cent is to be expected. There is frequently, during expansion, a partial reevaporation of the steam condensed during admission, and tests of multiple expansion engines driven with saturated steam and equipped with cylinder jackets and reheating receivers have sometimes shown the steam to be slightly superheated at release in the low pressure cylinder.

The use of high fire-test mineral oils for cylinder lubrication, and of metallic or asbestos packing, disposes of some of the most serious questions. More careful and more plentiful lubrication is required unquestionably than with saturated steam, for the presence of condensed steam on the cylinder walls is an undoubted aid to proper lubrication. The temperatures are not as high as those of gas-engine cylinders, and, in fact, unless the steam is highly superheated, the temperature at cut-off is probably but little above that of saturated steam.

Experience has shown that with engines of ordinary design using superheated steam a temperature at the throttle of 475° Fahr. should not be exceeded. How far the superheating can be safely carried with a given engine can be determined by experiment only, as it depends largely upon the construction. It often happens that a much lower temperature than 475° is found advisable, but even then a considerable saving may be made in the operating expense. If the temperature becomes much higher that 475°, operation may become impossible on account of the difficulty in lubricating the working parts properly, or the expenditure for lubricants may be so great as to neutralize any advantage derived otherwise. The lubrication difficulty prevents the use of unbalanced slide valves with very high temperatures, and compels the application of poppet valves, or completely balanced piston valves.

Some notion of the relative economy of different types of engine working with highly superheated or with saturated steam may be gained from the following table, given by Carl Jacobi in a paper read before one of the German engineering societies, in which the respective thermal efficiencies are expressed.

Comparative tests to determine the relative economy of saturated and superheated steam with varying degrees of superheat have been made with many different types and sizes of engine during the past few years, by various well-known engineers. To refer to even a small percentage would take too much time. A net gain in economy of 10 to 15 per cent is a common result, while a saving of 20 per cent, 25 per cent and even 30 per cent is by no means uncommon. Of course the largest saving is made with the more wasteful types of engine.

The most economical results thus far obtained have been secured with compound engines using superheated steam. It is common practice to omit the jacket from the high-pressure cylinder, but to retain it on the low, though some builders prefer to use a reheating receiver, with no steam jacket on either cylinder. Since the mission of the jacket is to reduce the initial condensation, it would seem useless to introduce it, with the extra complication and expense entailed, if the same result can as well be attained in another way.

TABLE I.

	Engines Working With			
	Saturated Steam.		Highly Superheated Steam.	
Type.	Horse-Power.	Thermal Efficiency, per cent.	Horse-Power.	Thermal Efficiency, per cent.
Simple non-condensing	30	6.7	30	12.5
Simple condensing	40	9.2	40	15.5
Compound condensing.	150	12.5	90	21.0

Judging from the results of ten experiments by Doerfel, a large saving can be effected in many old plants using compound engines, by superheating the receiver steam, even though it may not be possible to properly lubricate Corliss valves when using superheated steam at high pressures. The superheating could best be effected with highly superheated steam introduced into the heating coils of the receiver, and passing thence to the throttle valve.

Engines using this principle have been built in Bohemia. A compound engine, 29 ins. and 48 ins. x 52 ins. is running in a cotton factory in Schlan. The engine is underloaded, cutting off at one-tenth stroke, runs at 74 r.p.m., and develops 500 to 575 horse-power of steam of 100 lbs. boiler pressure. The high-pressure cylinder is jacketed, and the steam, heated to a temperature of 550° Fahr., or thereabouts, passes through the heating coils of the receiver, and the high-pressure jacket, before reaching the steam chest. A test showed that the receiver steam, at 2 lbs. pressure, was superheated by this arrangement 110 degrees, and the steam per horse-power counted for at cut-off by the low-pressure indicator card was 11.51 lbs., while the actual consumption by the engine was 11.84 lbs. per horse-power-hour. In other words, the device neutralized almost completely the initial condensation in the low-pressure cylinder. The steam temperature at the boiler was 594° Fahr.; before the receiver heating coils, 540°. and at the throttle, 405°.

In the case of large engines, where the cylinder cooling surface is small as compared with the volume of steam admitted, the walls might become so hot during a period of heavy load and late cut-off as to render lubrication difficult. Therefore, some engines have been built with a special valve under the control of the regulator, which during periods of overload admita steam from the main pipe to the heating coils of the receiver, cooling the steam before it reaches the throttle. An engine in Amsterdam tested by Professor Ewing has the valve so arranged that it opens when the receiver pressure rises, that fact implying that a smaller part of the whole expansion is taking place in the high-pressure cylinder; that there is less need of superheat there, and that it is advantageous to transfer the excess to the low-pressure cylinder. For simple engines saturated steam may be drawn directly from the boiler to mix with the superheated steam. In the extreme position of the regulator equal quantities of saturated steam may be drawn directly from the boiler to mix with the superheated steam. In the extreme position of the regulator equal quantities of saturated steam and of superheated steam are admitted in the attempt to keep the packing rings always in a zone of saturated or of slightly superheated steam.

If superheated steam be used in an old pipe line designed for saturated steam, there will be found a diminished difference in pressure between the two ends of the main, because a gas of much less density is handled, without entrained moisture and with less friction. With a speed of 100 ft. per second, the loss in pressure will be no more than with a speed of 60 ft. for wet steam. The larger the pipe, the greater the loss by radiation; the smaller the pipe, the greater the loss by throttling. The loss by radiation may be 1° Fahr. for 2 ft. of pipe, but with good thick covering, a very high steam speed, and a correspondingly small radiating surface; the loss has been reduced to 1° for 6 linear ft. of piping.

The demand for condensing water is no greater with superheated than with saturated steam, and it may easily be less. A portion of the added heat is turned into work and if more heat per pound of steam goes out with the exhaust, since the steam consumption is diminished, the demand for cooling water should be no greater and possibly less.

The installation of a superheater is equivalent to an increase in boiler capacity, and enables intermittent loads to be handled without danger of water being carried over to the engine cylinder. Almost any kind of superheater can be fired independently, or can be arranged in connection with the boiler flues, so as to dispense with the separate furnace. The latter arrangement is usually preferred, as it is found to be more economical, and the tubes can better be protected from the extreme heat of the firebox. Where the engines are placed at a long distance from the boilers, an independent superheater becomes advisable. The first cost may be greater but it need not entail a large expense for maintenance, because the furnace can be fired at intervals of several hours, the fire left to burn slowly as in an ordinary stove, and a more even temperature maintained. The space required is small, and repairs can easily be made if a suitable by-pass is provided, without in any way hindering the operation of the rest of the plant.

If the coils are placed directly in the boiler flues—without dampers, by means of which they may be protected from the hot gases—provision is generally made for flooding them with water while the boiler is being warmed before steam is generated. With bad feed water this introduces difficulty with mud or scale which must be guarded against, or a careless manipulation of the valves may cause a dangerous water-hammer. It is, therefore, better practice to dispose the superheater so that it can be protected at such times by dampers, and be subjected to the action internally of steam alone.

Cast-iron superheaters have the advantage that they can withstand without injury any temperature to which they are likely to be exposed, when properly placed. They are so much heavier and thicker than wrought iron, besides being ribbed after the fashion of a gas engine cylinder, that they require a higher heat for the same useful effect, but, at the same time, they serve as reservoirs of heat and tend to equalize the temperature of the steam in spite of wide variations in the furnace temperature. They must be accessible so that the soot can easily be blown from the ribbed surfaces. The use of cast-iron for such a purpose introduces a certain element of danger, though perhaps inconsiderable, on account of the porosity of castings in general, and the particular likelihood of spongy places occurring in ribbed castings.

If the superheater were placed in the chimney, or in the main flue leading to it, too high a temperature of the flue gases would be required for an economical utilization of the heat. If the gases went out at a moderate temperature, 350° to 500°, the temperature of superheating attained would be so low as to be of little value. If placed too near the fire, the superheating coils could not withstand the heat. Hence an intermediate position must be chosen, where the gases have lost some of their heat but may yet give up more to the water-heating surface.

It is an interesting fact that neither cast iron nor steel lose in tensile strength when subjected to the temperature of superheated steam, but, on the contrary, may become stronger. Tests made at the Watertown arsenal and summarized by Professor Lanza showed that the tensile strength of steel diminishes as the temperature increases from 0° Fahr., until a minimum is reached between 200° and 300°, mild steel reaching the point of minimum strength at lower temperatures than higher carbon steels. From this point they display greater tenacity, increasing sometimes as much as 25 per cent, as the temperature increases, until a maximum is attained somewhere between 400° and 650°.

[The foregoing is an extract from a paper read before the Milwaukee meeting of the American Society of Mechanical Engineers.]

◆

THE REGULATION OF ALTERNATING-CURRENT GENERATORS.

BY A. S. M'ALLISTER.

The present accepted meaning of the term regulation as applied to alternating-current generators is the percentage increase in terminal e.m.f. when the full load, of a specified power factor, is thrown off, the speed and field current remaining the same. It differs in magnitude only from the relative drops of terminal e.m.f. at constant field excitation and speed with increase of load. Satisfactory operation demands that the regulation be within certain limits, according to the nature of the service to which the generator is applied. A high degree of regulation is desirable in any case, but, with a given generator, it can in general be secured only by methods which tend to increased cost of construction. In what follows will be given a discussion of regulation as affected by the number of phases and the character of load on each phase.

There are three causes of variation of terminal e.m.f. with change of magnitude or character of load. Of these three, two act to decrease the apparent e.m.f. without in general affecting the internal generated e.m.f., while the third—usually the most pronounced—varies the magnetism from the field and thus alters the internal e.m.f. The first two, resistance and inductance, are common to all circuits carrying alternating currents, and the methods by which they may be decreased are immediately apparent. In properly-designed alternators the drop due to armature resistance is quite small and usually much less than that due to inductance. In the armature-resistance drop is included that due to the hysteresis loss, from the local magnetic flux around the armature conductors, which appears as a power component of the armature-impedance drop. The inductance is due to the local flux around the armature conductors. This flux depends directly upon the current in each conductor and inversely upon the reluctance of the magnetic path around the conductor. It is evident that when the path is closed by magnetic material this flux will be greater than when an air-gap is interposed.

With respect to mechanical construction in this detail, methods in use differ widely. American alternators were formerly built with slots having the full width of opening at the top, thus tending to limit the local armature flux. With such slots the effective armature surface for field magnetism is evidently less than with closed slots or tunnels. European alternators, on the contrary, have previously been designed almost wholly with tunnels, in order to give mechanical protection to the coils, the magnetic result being a high local flux. Present practice indicates a compromise between the two methods, so that both American and European alternators now extensively employ half-closed slots, somewhat like that shown by Fig. 1.

The counter e.m.f. of self-induction depends upon the interlinkage of the flux with the armature conductors. When a single conductor occupies a slot the local flux set up by the current within it passes almost wholly around that conductor alone. When, however, several conductors occupy the same slot the flux of each conductor surrounds the other conductors so that the relative interlinkages per slot are as the square of the conductors therein. For this reason, in well-designed alternators there are many slots and few conductors, while the best of modern alternators are built with one conductor per slot.

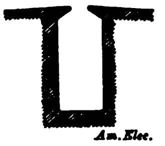


FIG. 1.

The effect of armature resistance and reactance on the terminal e.m.f. can best be determined by considering the armature to be free from both, and the load current to be passed through an impedance coil having resistance and reactance equal to that of the armature. It is well known that the difference of potential across the immediate terminals of a given impedance coil will depend only upon the amount of current passed through it, but that the apparent drop in the circuit external to the coil will depend upon the phase relation of the current and e.m.f. In general an inductive load will cause a greater apparent drop than a non-inductive, and the lower the power factor the greater the apparent drop. This is true with any current having a power factor greater than that of the armature impedance. With a decrease of power factor of the load current below this value the apparent drop will be decreased. It should be noted that this effect is entirely independent of the change of field magnetism with character of load. In fact, for the above discussion the field magnetism has been considered constant.

The third, and by far the most important, cause of change in generator e.m.f. with change in load is the effect of the armature current upon the field. As stated above, the armature current tends to alter the internal generated e.m.f. The internal e.m.f. is determined by the rate of cutting lines of force by the armature conductors, and therefore, with constant armature speed, depends directly upon the strength of the magnetic field. The field strength is determined by the exciting current and the current flowing in the armature; the armature current may either increase or decrease the field magnetism, according to its direction of flow.

A current which lags behind the e.m.f. one-quarter of a cycle will directly oppose the field magnetism, while one which leads its e.m.f. by one-quarter of a cycle will directly assist the field magnet. This will be clear from an inspection of Figs. - to 5. If the armature current is precisely in phase with its e.m.f., it will attain its maximum value when the coil is in the position shown in Fig. 2, producing a polarity at the periphery of the armature, as indicated by the letter *s*. Now, if the current lags behind its e.m.f. one-quarter of a cycle, the coil will have reached the position indicated in Fig. 3 when the current attains its maximum value, and the pole induced on the armature core will be in direct opposition to the field-magnet pole. Similarly, with the current in phase with its e.m.f., when the coil reaches the position shown in Fig. 4, the current will have reached its maximum in the opposite direction, inducing a north pole at the periphery of the armature midway between the two field-magnet poles, as indicated. If, however, the current leads the e.m.f. one-quarter of a cycle, it will have attained its maximum one-quarter of a cycle before the coil reaches the position shown by Fig. 4; that is, when it is in the position indicated in Fig. 5. This position is the same as that indicated in Fig. 3, but the result is different, because as the current leads the e.m.f., it will have the opposite polarity and induce a magnetic flux the polarity of which is such that when it attains its maximum value it assists the field magnetism, as indicated by the lettering on the diagram.

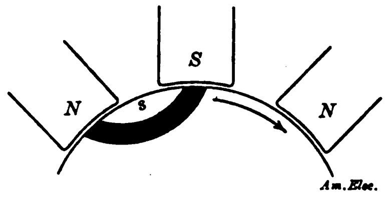


FIG. 2.

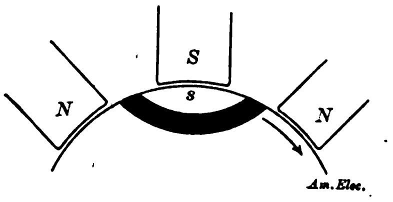


FIG. 3.

The total current cannot possibly lag one-quarter of a cycle, as this would mean that it would be entirely wattless; but a current which leads or lags less than one-quarter of a cycle can be resolved into two components, one wattless and in exact quadrature to the other, which is the power component; the wattless component thus opposes or assists the field magnetism as just described. The relation between this wattless component and the total current is that between the sine of an angle and the radius, the angle being the one whose cosine is numerically equal to the power factor of the current. For example, a current of 100 amperes having a power factor of .90 will have an inductance factor of .44, so that the wattless component will be equivalent to a current of 44 amperes lagging one-quarter of a cycle behind its e.m.f. Therefore, 44 amperes of the total 100 will directly oppose the field magnetism. The disadvantage to generator regulation which is entailed by operating loads having low power factors will be evident from the foregoing.

If the armature current is strictly in phase with the e.m.f., it tends of itself neither to increase nor decrease the field magnetism, but merely to distort the lines of force, and, by irregularity of distribution over the pole-faces, to increase the effective field reluctance and thus indirectly to decrease the field strength. The number of lines cut by the armature conductors is further decreased by the distortion of the path of lines from pole to pole.

In a polyphase alternator the armature currents produce a magnetic field which rotates in the backward direction with respect to the armature core, at the rate of one pole per alternation, and is therefore stationary with respect to the field poles. If the currents are strictly in phase with the e.m.f., and the circuits are balanced. the armature poles lie midway between the field poles and are of a constant strength. If the circuits are balanced but the load has a power factor less than unity, the armature poles are of a constant strength but are nearer to one or the other of the neighboring field poles—for an inductive load, poles of same polarity coming more nearly together, and for a capacity load, opposite poles approaching each other.

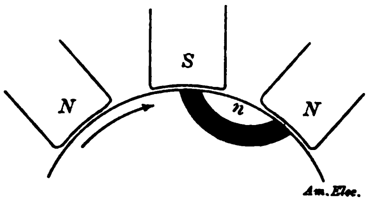


FIG. 4.

If the current in each phase is of the same power factor as that in each of the others, but the phases are unequally loaded, then the armature poles fluctuate in strength but have a constant position with reference to the field poles. If each phase carries the same current but has a different power factor from that of the other phases, then the armature poles have practically a constant strength but oscillate back and forth between the field poles. If the phases are unequally loaded and the currents are at different power factors, the armature poles will both fluctuate in strength and oscillate in position. This shifting of the armature poles causes hysteresis loss in the field-magnet pole-faces and a tendency to irregular torque, and is in general detrimental to good

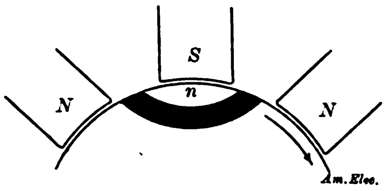


FIG. 5.

performance of the alternator. In a single-phase alternator the armature poles evidently disappear once for each alternation of the current, but do not shift their position except with change of the power factor of the load.

With a two-phase machine carrying a load of unity power factor, when the current in one phase is a maximum the other is in position to cut no lines; while when one phase is idle the other is developing its highest e.m.f. At these two positions, each phase operates entirely independently of the other phase with reference to armature reaction, while at intermediate positions the field magnetism cut by the windings of one phase is distorted by the current of the other phase. We thus see that each phase of a two-phase generator regulates almost independently of the other phase for unity power factor load. If one phase carries no load, and the other is fully loaded, the field magnetism cut by the windings of the phase running light will be practically that due to the field exciting current alone when the current on the loaded phase has a unity power factor; when the power factor is less than unity—that is, the load current either lags behind or leads its e.m.f.—the time of maximum current flow will be more nearly in unison with the time of cutting the maximum lines from the field by the phase running light, so that the field magnetism which generates e.m.f. in the unloaded phase winding will be affected by the current in the other phase.

On a three-phase machine the coils of each phase are located mechanically and electrically nearer to those of the other phases than is the case on a two-phase machine. Any effect which the current in one phase has on the field magnetism is felt by the coils of the other phases, so that if it were possible to load one phase of a three-phase machine while the other two carried no load, the voltage on all three phases would be affected by the flow of current in the one alone. It is only under very exceptional circumstances that a load on one phase of a three-phase circuit will not draw current from at least two of the three generator phases, and it is therefore obvious that the regulation of each phase of a three-phase generator is dependent upon the load on the other phases also.

Where it is desirable to maintain constant pressure on one set of feeders while the load fluctuates on another, a two-phase generator offers some advantage over a three-phase. In this case potential regulators may be used to adjust the pressure on each phase quite independent of the other. When compensation for internal generator or other transmission drop is made by increasing the field strength, it is desirable to have the pressures on all phases fluctuate together, for which service the three-phase generator is better adapted than the two-phaser. Since this latter method is the more convenient and economical, modern design is dictating more and more exclusively alternators of the three-phase type.

Where the service is such that the phases are never subjected to inequalities of load, as in the case of general power-transmission equipments, there is no choice between two-phase and three-phase generators with reference to regulation. In this case, however, three-phase circuits for transmission are the most economical, and when the line voltage is below 15,000 three-phase generators feeding directly to the line give the best results. When step-up transformers are necessary, either two or three-phase generators may be used, though for both local and long-distance supply three-phase generators are better.

Abstracts from Foreign Contemporaries

Measuring Instruments Having Magnets.—Measuring instruments in which the action of a current upon a magnet is utilized are, according to an article by P. Weiss in a recent issue of the "Comptes Rendus," liable to change in their sensitiveness, owing to changes in the magnetic moment of the magnet. Weiss compensates these changes in the manner shown by Fig. 1; where *m* is a small needle of soft iron, rigidly connected with the movable coil, and *N S* are the poles of a permanent magnet. When the latter increases in strength, the deflection is increased by the increased action upon the coil and diminished by the increased action upon the needle. If the needle is saturated, the deflection for the same current will be the same as before. In practice, he compensates for any lack of saturation by a slight antagonistic couple in the elastic suspension.

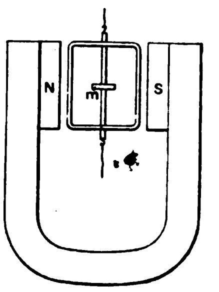


FIG. 1.

Adjusting Voltage for Testing Purposes.—In calibrating and testing voltmeters, wattmeters, etc., it is often desired to obtain a certain given voltage at the points of connection for the instruments. The method used in the Austrian Calibration Office is described by W. Marck in a recent issue of the "Zeitschrift für Elektrotechnik." For direct current the arrangement shown by Fig. 2 is used. The terminals of the supply circuit are *A* and *B*, between which is connected a non-inductively wound coil of manganin wire which can carry continually a current of about 1.1 amperes. The resistance of the coil is almost 160 ohms and it is divided into two main parts by the tap, *J*. The part between *J* and *B* is divided by taps into 30 equal parts, each one of which is slightly smaller than the total winding between *A* and *J*, which is itself also divided into 30 parts. The taps are led to the contacts of two dial switches, *F* and *G*; the contacts *f* and *g* have no connections. The measuring instruments are connected between *C* and *D*. The levers, *F* and *G*, are turned to contacts, *f* and *g*, when the switch is used for determining the zero point of the instrument. The voltage desired at *C*, *D*, may be obtained roughly by adjusting the lever, *G*, and accurately by adjusting the lever, *F*. If the voltage of the supply current is slightly more than is desired, the greatest possible error in the adjustment is .056 per cent. When dealing with alternating currents, if the voltage is higher than required the method mentioned for direct currents will also be available. If the voltage is too small a transformer is used to bring it up to the desired value. Simpler still is the method shown by Fig. 3, where *A* and *B* are the terminals of the supply circuit and *C* and *D* are the terminals for the instruments. The diagram is self-explanatory.

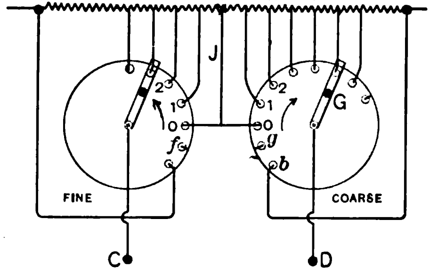


FIG. 2. DIAGRAM OF CONNECTIONS.

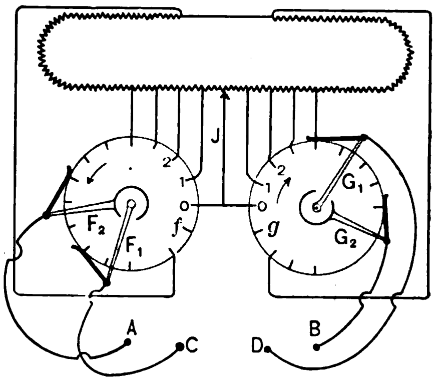


FIG. 3.—DIAGRAM OF CONNECTIONS.

Closing Portable Storage Battery Cases—The "Centralblatt für Accumulatoren" recently described a new method for closing portable storage battery cases. The ebonite covers of storage battery cases are provided with soft rubber borders which are firmly connected with the cover during vulcanization. The soft rubber border is cut off in such a way that the lower part of the cover fits exactly into the opening of the case, and the upper part presses firmly against the walls of the case. A small hole in the cover permits the escape of the generated gas. The arrangement is said to have proved very practical, only an hour being required to clean an automobile battery of 42 cells, including the time for connecting and disconnecting all screws.

Small Telephone Exchange Without Cords.—The principle of an old form of telephone board has been revived, in a modified form, in a cabinet board for small exchanges described in a recent issue of the "Elektrotechnischer Anzeiger" and which is now being introduced with the idea of eliminating the troublesome flexible cord. As shown by Fig. 4, the jacks are arranged in a triangle, so as to give the necessary number of combinations; the jacks being marked with the two lines which they connect. There are thus 15 five-point connecting jacks for a six-line board, the top one being marked 1—6, and the lower row consisting of five. Below this is the row of six local jacks, which are connected to the operator's set by merely inserting a loose plug, just as in the case of the main jacks. At the top of the board is a row of six drop indicators employed both for calling and clearing signals, and a corresponding row of jacks in case connections are to be made to other boards, and to the right and left of the triangle are jacks to connect in the bell and extension bell if required. The boards are made in sizes for from 3 to 20 lines.

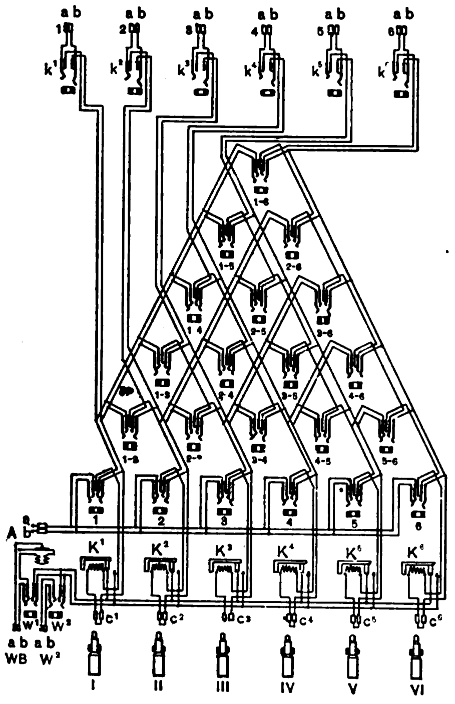


FIG. 4.- SWITCHBOARD DIAGRAM

Haas and Oettel Hypochlorite Cell.—Mr. J. B. C. Kershaw, writing in the London "Electrician," says that the difficulties met with in the production of sodium hypochlorite by the electrolysis of solutions of common salt have been two in number. In the first place, secondary electrolytic and chemical reactions have caused the decomposition of the hypochlorite—originally formed; and in the second place, owing to the use of platinum as electrode material, the capital outlay upon the cell or apparatus has been high. These difficulties, it is said, have been satisfactorily surmounted in the latest form of Haas and Oettel cell shown by Fig. 5. It consists of an oblong box made of any suitable material, provided with two terminal electrodes and a large number of intervening secondary or double-poled electrodes. One terminal electrode is of lead; all the others are of specially-prepared carbon. The secondary electrodes, usually 27 in number, are kept in position by grooves in the sides of the containing vessel. Ordinary carbon in such a cell would soon disintegrate, but the special carbon plates used have a comparatively long life, and little discoloration of the resulting hypochlorite solution is observed. The electrodes are submerged in the electrolyte, which flows in a zigzag fashion through the cell. A current of 1000 amperes per square meter is used, with a salt solution testing 6° B. The cell is mounted upon trunnions, so that it may easily be inverted for rinsing-out purposes, and the whole operation of cleaning can be carried out in this manner in a few minutes, without removing any of the electrodes. A settling tank is provided to allow any solid particles of carbon or other impurities to settle, and the electrolyzed solution is then ready for use in the bleaching vats. The carbon electrodes, with proper use, last six months, but soft water and salt free from calcium, must be used to prepare the electrolyte, in order to avoid deposition of calcium hydrate at the cathodes. The size of cell most generally adopted utilizes a current of 45 amperes at 110 volts, and under such conditions yields 9 kg. of active chlorine in 10 hours.

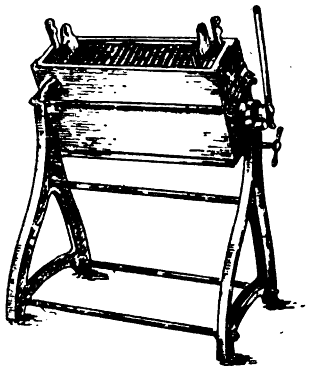


FIG. 5.—HAAS AND OETTEL CELL.

German Imperial Electrical Standards.—A recent issue of the "Elektrotechnische Zeitschrift" contains the following specification issued by the German government for the preparation of the silver cell in measuring the standard ampere: The solution is to contain 20 to 40 parts by weight of pure nitrate of silver to 100 parts of distilled water free from chlorine, and it must not be employed after 3 grammes of silver per 100 cubic centimeters of the solution has been deposited electrolytically. The part of the anode within the liquid is to be of pure silver, and the cathode of platinum. If the silver deposited on the latter exceeds 0.1 gramme per square centimeter the silver must be removed. The current density is not to exceed 1/5 ampere per square centimeter at the anode, and 1/50 ampere per square centimeter at the cathode. Before weighing, the cathode has to be washed with distilled water free from chlorine until the rinsing water shows no cloudiness when a drop of hydrochloric acid is added to it; then it is to remain in distilled water at 70 to 90° C. for ten minutes, and again rinsed in distilled water. This last rinsing water must not show any cloudiness when treated cold with hydrochloric acid. The cathode is then dried in heat, and is kept in a dessicator until it is weighed, and after it has been cooled at least 10 minutes must elapse before the weighing. In addition to the volt, ampere and ohm, the names ampere-second or coulomb, ampere-hour, watt, watt-hour, farad and henry, and the prefixes kilo, mega and meg, milli and micro are now legalized, as are also the general acceptance of the terms effective, mean, electrolytic, and maximum momentary value of alternating or variable currents, e.m.fs., or pressures. The limits of error of electricity meters are also fixed as follows: For continuous current meters—(*a*) Between the maximum load for which the meter is intended and 1/10 maximum load, the error must not be greater than 0.6 per cent of the maximum load plus 6 per cent of the load the meter is carrying at the time, and at loads of 1/25 full load an error of 2 per cent of the full load is permissible. In the case of meters on lighting networks, however, these restrictions do not apply to power consumptions below 30 watts. (*b*) When no electric power is being consumed the meter must not run forward or backward at a rate greater than that corresponding to ½ per cent of its full load. In alternating and polyphase meters the same conditions apply as for continuous-current meters, with the exception that if there is a difference in phase between the pressure and current used, twice the tangent of the angle of lag is to be added to the percentage error determined under the rule (*a*) above, the angle of lag being taken as the angle whose cosine is the power-factor of the circuit.

Increasing the Capacity of Lead Accumulators by Heating.—A recent issue of "L'Eclairage Electrique" contains an illustrated note on a patent of Heim, who suggests heating the lead accumulator, in order to diminish the viscosity of the sulphuric acid and quicken the diffusion. This is said to result in a large increase of capacity, which tests have shown to amount to 3 per cent per degree centigrade. For an increase of temperature of 33 1/3 degrees this would obviously double the capacity, provided the rate of increase were maintained.

Boilers and Engines for Superheated Steam.—In a paper recently presented before the "Verein deutscher Ingenieure" at Essen, by Herr Hunger, recent advances in the production and use of superheated steam are discussed. Regarding the boiler, the author emphasizes the fact that ample space should be provided in the flues to receive the superheater, and that an increase in chimney draft should be given to offset the increased resistance to the gases in passing through the space about the superheater tubes, as otherwise the introduction of the superheater may result in a decrease of boiler efficiency. The steam engine should be designed with special reference to the use of superheated steam. It is a common error, the author points out, to use the same size of cylinder for superheated as for saturated steam; whereas in a given engine for the same point of cut-off, steam superheated from 860° to 950° Fahr. gives less power than saturated steam. He cites a case where Professor Schröter was unable, in a test, to start a 1500 h.p. engine when the temperature was raised above 716° because the piston expanded and was bound in the cylinder. For like reasons slide valves or cylindrical valves have given poor results, and poppet valves have been found preferable. Herr Hunger calls attention to several points of importance in connection with the design of superheater plants, which embody the results of much experience. The best boiler for this service, he says, is a shell boiler with large steam and water space, permitting good combustion and generous proportion of flues. The general form of modern engines may be followed, but special care should be taken that the high temperatures should not act to curve the cylinder. The valves and stuffing boxes must be constructed to withstand the heat and to remain both tight and free from excessive friction. The superheater tubes should be well drained, and the flues for conducting the hot gases should divert a portion of the gases from the superheater by a by-pass, otherwise when the boiler is forced excessive superheating may result, to the injury of the engines. A rate of combustion of about 16.5 lbs. of coal per square foot, has been found to deliver the gases at a sufficiently high temperature to insure satisfactory superheating. He discountenances the use of separately fired superheaters, the gases being too hot and resulting in a speedy destruction of the tubes.

Some Recent Electrical Patents

Regulator for Series Alternating-Current Circuits.—Fig. 1 herewith represents a constant-current regulator which has been patented by S. D. Sprong for use on series circuits supplied by constant-potential transformers. The engraving is practically self-explanatory. The regulator consists of two solenoid coils, *A A*, mounted on a cross-bar, *B*, suspended from the outer ends of two rocking levers; from the inner ends of which levers is suspended a U-shaped laminated iron core, *C*. The coils are connected in series with the circuit, and it is obvious that any increase in current strength will draw the core downward and the coils upward until the increase in reactance thus produced cuts down the current sufficiently to establish an equilibrium. Patent No. 674,942.

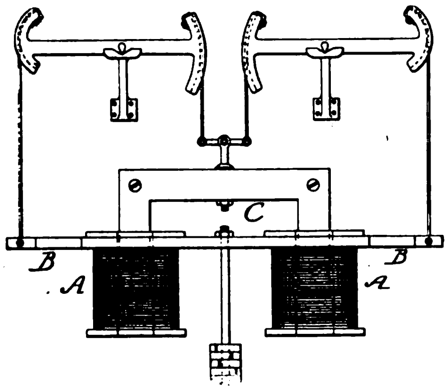


FIG. 1.—CONSTANT CURRENT REGULATOR.

Nernst Lamp Starter.—It is well known, of course, that the glower rod of a Nernst lamp must be heated in order to allow current to pass and bring the rod to incandescence. Many kinds of heaters have been devised for this purpose, almost all of which consist of some form of heating coil arranged in proximity to the rod. Quite a departure from this method has been patented by Isidor Kitsee, the principle of which is illustrated by Fig. 2 herewith. This method of starting consists of delivering a spray of acidulated water or similar liquid on the glower rod. The moisture on the surface of the rod constitutes a conductor and starts the current along the surface of the rod, which thus becomes heated and is brought to incandescence. The liquid preferably used by the inventor is a 2 per cent aqueous solution of sulphate of magnesium. Patent No. 677,238.

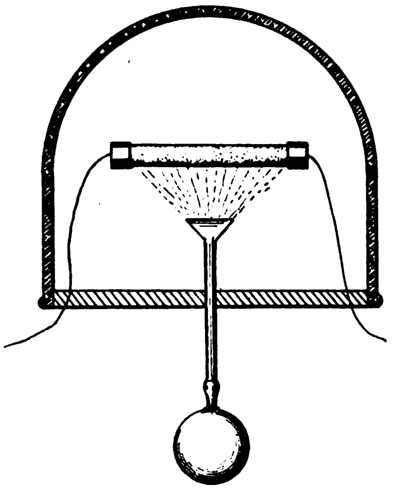


FIG. 2.—NERST LAMP STARTER.

Dynamo or Motor Pole-Piece—It is a common expedient in dynamo and motor construction to increase the air-gap gradually from a point near the pole tip out to the tip itself in order to provide a well-graduated commutating field and distribute this field over a considerable area.

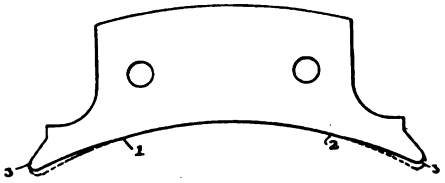


FIG. 3—DYNAMO OR MOTOR POLE PIECE.

This construction has been in use for several years in machines having ordinary cast pole-pieces, so that it seems rather remarkable that Frank A. Merrick should have succeeded in obtaining a patent for the laminated pole-piece shown by Fig. 3, the feature of which is the graduation of the air-gap in the manner mentioned. The patent, of course, only relates to laminated pole-pieces, and only covers a pole-piece in which the face is continuously concave, but of increasing radius from points each side of the center out to the pole-tips, as indicated by the figures 1, 2 and 3 and the dotted lines. Patent No. 676,439.

Polyphase Arc Lamp.—One of the difficulties attendant upon the use of polyphase currents for a universal distributing system lies in the fact that arc lamps do not operate satisfactorily at low frequencies, while on the other hand it is difficult to build rotary converters satisfactory for the frequencies suitable for arc lighting. With a view to providing an arc lamp which will operate satisfactorily at low frequencies and thus eliminate this difficulty, E. W. Rice, Jr., has devised and patented the form of lamp shown diagrammatically by Fig. 4. The lamp is provided with a single upper carbon and two lower carbons, two arcs being formed between the upper and lower carbons. The diagram shows the lamp supplied from a two-phase system, in which case the upper carbon must be larger than the lower ones, because the current which it carries is equal to the vector sum of the two currents passing through the lower carbons. With such an arrangement there is no momentary interval of entire extinction, for the reason that when one current is passing through zero there is still

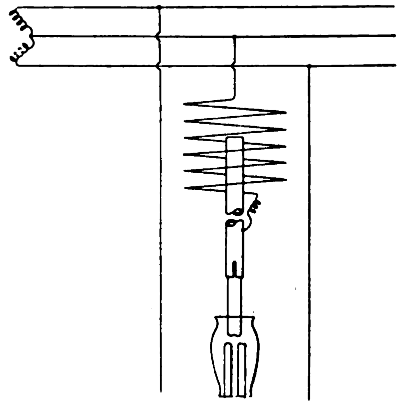


FIG. 4.—POLYPHASE ARC LAMP.

the arc due to the other current. As the sum of the current through the upper carbon and the two currents through the lower carbons is a constant value, the total luminosity of the two arcs will be fairly constant, even at low frequencies. It is necessary, of course, that the distance between the two lower carbons be appreciably greater than the length of the arc, in order to avoid the formation of a third arc horizontally between these two carbons. Re-issued Patent No. 11,916.

Shunt for Dynamo Compounding Coils.—When compound-wound generators are used to carry violently fluctuating loads, it is noticeable that a sudden and considerable increase in load causes a momentary drop in voltage, notwithstanding the compound-wound field. This is due, according to H. M. Hobart, to the difference between the time constant of the series field winding and that of the resistance strip connected in shunt to it.

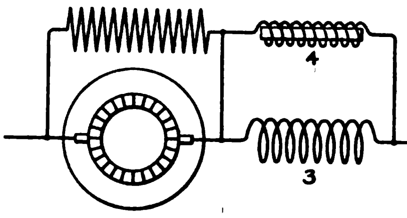


FIG. 5.—DIAGRAM OF CONNECTIONS.

For example, when the heavy load comes on, the shunt strip having no inductance, presents only the opposition of resistance to the increase in current; whereas the series winding is self-inductive and its reactance opposes momentarily the sudden increase in current flow through the winding, so that before the current through the series coils attains the value which it would have if opposed only by the resistance, the voltage of the machine is cut down by armature reaction, etc. As a remedy for this condition Mr. Hobart proposes using an inductive shunt instead of a plain German-silver strip, the time constant of the inductive shunt being made approximately the same as that of the series winding of the generator. Fig. 5 herewith illustrates diagrammatically the arrangement; the series winding is represented by the figure 3, and the inductive shunt by the figure 4. Patent No. 677,355.

◆

The Oil Lamp as Applied to Commercial Photometry.

To the Editor, American Electrician;

Sir:—Referring to Professor Stine's article, "The Choice of a Photometer for Central Stations," which appeared in the June issue of the American Electrician, while there may be no criticism to offer as to the merit of this article from a strictly technical standpoint, it would seem that in his severe arraignment of the oil lamp secondary standard type of photometer, Prof. Stine has been guided by purely theoretical ideals and scientific standards rather than by a practical knowledge and careful consideration of the actual requirements of the average central station or other commercial user of incandescent lamps, who merely desires some means of determining the relative merits of the various makes of incandescent lamps offered to him. To such persons the positive accuracy to be obtained only by the use of a Lummer-Brodhun screen on an expensively equipped and finely-adjusted laboratory photometer connected to a battery circuit to insure the maintenance of an absolutely constant potential, and provided with all the refinements of laboratory usage in the way of nicely standardized current and pressure indicating instruments, is not nearly so essential as would be any special features calculated to insure extreme simplicity of operation and a reasonable degree of accuracy combined with the lowest possible cost of the instrument and accessories consistent with the two previously mentioned qualities.

In this connection it might be well to mention that by "reasonable degree of accuracy" is meant accuracy which enables a fairly experienced operator to test with ease upward of 300 lamps per hour, making readings to within one-tenth of one volt, or one-tenth of one candle-power of absolute accuracy—which, by the way, is much closer than any lamp manufacturer would think of marking his product.

In perfecting the oil flame secondary standard type of photometer, the requirements of commercial users of incandescent lamps were carefully studied by men already experienced in such details, and the final adoption of the oil flame as a secondary or working standard of light, was the result of a thorough conviction that, all things considered, it was best adapted for the purposes of commercial lamp photometry.

The difference in color between the light from an incandescent lamp and that produced by an ordinary oil flame is of itself very slight, and by reason of the method always employed in standardizing the oil flames photometrically (not mechanically) from a primary standard incandescent lamp, this color difference is automatically compensated for to a degree rendering it of practically no importance whatever, especially in commercial lamp testing, which is carried over a range of from only 7 to 33 candle-power.

Granting that the use of the oil flame secondary or working standard of light may leave something to be desired in the matter of retention of standardization, the oil lamp with wicks properly trimmed and a full supply of oil in the well will burn constantly and evenly without readjustment for upward of one hour, and in some instances has been known to retain standardization for a much longer period. Even under the worst possible conditions it is seldom necessary to check the oil flames in comparison with the primary standard of light at more frequent intervals than 20 to 30 minutes. In the present type of oil lamp secondary standards, the ragged edges, or flickering portion of the top of the flame is completely cut off by an adjustable screen or mask, greatly increasing the life of the secondary standard and completely removing the principal cause of the inconstancy encountered in an ordinary oil flame. The fact that the oil flame secondary standard is used at only about one-third of its normal rated volume also assists to increase the constancy of the flame.

Offsetting any slight disadvantages of the oil flame secondary type of photometer on account of difference in color of light or lack of constancy of the petroleum flames, and amply compensating therefor (should it still be contended that these objections are sufficiently serious to be considered), are several distinct features especially commending this type of photometer to the commercial user and photometric tester of incandescent lamps. First, and by no means unimportant in the eyes of the user, is the fact that there is but one controlling rheostat—only one voltmeter to be constantly watched—which means that only two people, one operator and an assistant, are required to properly carry on photometric lamp testing; and it is quite practicable for one person working alone to satisfactorily test lamps in limited quantities. Aside from the economy in labor thus afforded is also to be considered the even more desirable feature of requiring the use of only one voltmeter, whereas with any other type of photometer two of these expensive instruments would be practically indispensable. This is especially important in view of the fact that few people having occasion to make ordinary commercial lamp tests have readily available more than one reliable voltmeter.

Second, but of almost equally great importance, as almost totally eliminating the common and serious source of personal error invariably encountered in photometric measurements with the Bunsen screen, is the principle of the secondary standard applied in the oil secondary type of photometer. As a result of the application of this principle, two or more operators with entirely different powers of vision will, if they can see sufficiently well to make photometric measurements of any accuracy whatever, invariably check their own and each other's work much more closely than with any other type of instrument employing a similar screen; totally inexperienced operators having readily taken readings and checked each other's work to within one-tenth of one volt and one-tenth of one candle-power. This is easily explained by the fact that each operator sets up his own secondary standard of light according to his own powers of vision, using in each instance the same style of primary standard lamp, an incandescent lamp known to be absolutely accurate under certain mechanical conditions easily produced and requiring no discretionary effort upon the part of the operator. As the lamps to be tested are also incandescent lamps which produce on the photometer screen practically the same results and color effects as the primary standard lamps from which the oil flames are first standardized, and as all incandescent lamps (the lamps being tested as well as the standard lamps) are always used on the same side of the photometer screen, it becomes apparent that the element of personal error, as well as the question of difference in color, is largely overcome, the actual function of the oil flame being merely that of a convenient medium of comparison. In the case of two operators of radically different powers of vision it might be found that in one instance the oil flames, after being standardized, actually gave more or less light than they did in another, although the results as they appeared on the screen to the eyes of both operators would be identical.

Similar reasoning applies in the matter of permitting reasonably accurate photometric readings in a room not absolutely dark, so long as whatever light there is in the room be constant as to position and volume; though, of course, the darker the room the more perceptible will be differences in effect produced on the photometer screen, and consequently the easier the work of making accurate readings.

As previously stated, where the oil secondary standard is used, it is necessary to compare the oil flames with the primary standard at frequent intervals; but so far as this is concerned, no photometer, no matter how perfectly adjusted and accurate, should be used for any considerable length of time without checking the working standards used. Such standards are all subject to more or less serious and rapid deterioration from one cause or another if in constant use; and, moreover, impressing upon the operator the necessity for frequent checking will discourage over-confidence upon his part. Furthermore, three or four primary standard lamps furnished with each photometer provide an ample precaution against unobserved deterioration of the primary standards. All of these facts really tend toward increasing the probable degree of accuracy obtained in commercial lamp testing on the oil lamp secondary standard type of photometer.

Of course, some of the advantageous principles applied in the oil secondary standard type of photometer may also be applied to an instrument using a low economy incandescent lamp as a secondary or working standard instead of the petroleum flame; but unless a storage battery circuit is available, such application must be at the expense of much additional labor and far less certainty of even reasonable accuracy, owing to the irregularity of potential to be contended with on commercial lighting circuits. Besides, two voltmeters are almost indispensable, a double-throw switch permitting the use of one voltmeter being an unsatisfactory arrangement for use on a circuit of varying potential.

The manufacturers of the petroleum flame secondary type of photometer have sent out nearly as many instruments employing the incandescent lamp secondary standard as of those using the oil flames, but always for use where storage battery circuits were available. Were they not satisfied that the oil lamp secondary type of photometer was thoroughly well adapted to the requirements of the average commercial user of lamps, there is surely no reason to suppose that, with all the resources at their command, they would remain content to cry the merits of an inferior article. Backing the manufacturers' confidence in the oil lamp secondary type of photometer, are the disinterested opinions of hundreds of practical central station managers and electrical engineers who are using this type of instrument with uniformly satisfactory results, also the unqualified endorsement of many of the most prominent lamp-manufacturers whose salesmen carry this type of instrument, and who could not afford to use anything except a photometer which was most accurate and best adapted to the purposes of commercial lamp testing.

Last, but not least, is the universally respected opinion of the Franklin Institute which, in awarding to the designers of the oil lamp secondary type of photometer the Edward W. Longstreth Medal of Merit, makes official comment that "the instrument is well adapted for the purpose of its design"—the purpose of its design being strictly commercial lamp photometry.

If the commercial user of incandescent lamps requires all of the accuracy to be obtained only by the use of an elaborate and most expensive lamp testing outfit, he might not be satisfied with the oil flame type of photometer, though over a strictly commercial range it is undoubtedly as accurate as any type of instrument using a Bunsen screen. If, on the other hand, he desires a photometer which will combine a reasonable degree of accuracy, extreme simplicity in operation and low cost, both as to instrument and accessories, it would seem impossible to find an instrument so completely meeting all of these requirements as does the type of photometer employing the oil flame secondary or working standard of light.

Edwin J. McAllister.

NEW BOOKS.

Central Station Experiences. New York: Power Publishing Company. Cloth or boards; 108 pages, 6 x 9 ins.; 55 illustrations. Price, cloth $1.00; boards, 75 cents.

This is a reprint of a series of articles in the conversational style which originally appeared in "Power." Each chapter of the book describes an experience on the part of the engineer of a small station, and a solution of one or more forms of "trouble" common to the average central station of moderate size. The various chapters are understood to be based on leaves from the actual experience of a former central station manager; at any rate, the "troubles" related undoubtedly have counterparts in real life, and the remedies prescribed are technically correct.

The Induction Motor. By B. A. Behrend. New York: Electrical World and Engineer (Inc.). Cloth; 111 pages, 6 x 8½ ins.; 56 illustrations. Price, $1.50.

This is an admirable little treatise, intended chiefly for designers and practicing engineers. The author's treatment of the theory of the induction motor differs from that of most writers, being if anything less complex than that found in other authoritative works. A serious hindrance to the reader lies in the failure of the author to define all of his symbols. Nowhere in the book is there definitely ascribed any meaning to the letter z, which appears repeatedly. Working backward from the equations containing it, one finds that z is the total number of axial conductors per phase on the stator, but the author does not vouchsafe this information. There are numerous other instances of taking for granted a preknowledge by the reader which the latter cannot reasonably be assumed to possess. The book is mathematical in character, of course, and is not for beginners or others unfamiliar with alternating-current principles.

Elements of Electrical Engineering. By Charles Proteus Steinmetz. New York: Electrical World and Engineer (Inc.). Cloth; 332 pages, 6 x 9 ins.; 143 charts and diagrams. Price, $2.50.

Mr. Steinmetz's new book fills a niche in technical literature hitherto practically vacant, and should meet with a warm welcome. It is a most concise (in some instances too concise) presentation of the fundamentals of electrical engineering in the heavier branches, but the book is far from elementary in a didactic sense. The laws of electromagnetism, the induction of e.m.f., self-induction and mutual induction, and condenser action are stated clearly, with examples to assist the student's concept, and the application of these laws to the operation of direct-current and alternating-current machinery is shown by combined graphical and analytical methods. A student unaccustomed to Mr. Steinmetz's immense breadth of view and consequent generalization will be apt to complain that the book is not sufficiently explicit, but all requisite basic information is there if one has sufficient grasp to follow the author's comprehensive and condensed method of presentation.

NOTES.

Register for the Electrical Fraternity at the Exposition.—At the suggestion of Prof. G. F. Sever, Superintendent of Exhibits in Electricity Building at the Pan-American Exposition, a register has been provided at the booth of the American Electrician for the use and convenience of the electrical fraternity. Such a register will doubtless be of considerable value in enabling friends to find each other when at the Exposition and learn of each other's presence, especially during the coming conventions. Our booth is Section B, Electricity Building, near the northeast corner of the building.

Common Battery Telephone Systems.—In the article by W. S. Henry, which appeared on page 361 of the July number, the jack spring, *da*, located just above the calling plug near the right-hand end of the diagram, was erroneously shown as resting upon the sleeve of the jack. With the plug pushed in to the position shown, the spring, *da*, would be raised clear of the jack, breaking the circuit through the line drop, *Da*.

Progressive Burglars.—According to the daily press, two burglars recently caught red-handed at Yonkers, N. Y., were provided, among other facilities for acquiring wealth rapidly, with an electric bull's-eye lantern. The policemen who made the arrest mistook the lantern for some kind of bomb, and as a measure of precaution belabored the captives with extra vigor in order to preclude the possibility of combined suicide and revenge on the part of the burglars by means of the mysterious appliance.

Reversing of Rotary Converters.—It is a common experience to sub-stations containing rotary converters supplied from high-voltage lines to have the polarity of the rotary converters reversed by a short-circuit on the high-tension lines, so that when the rotaries are started again after an occurrence of this kind they give current in the reverse direction from what they did before. The possibility that this may occur should be remembered by all installing or in charge of rotary converter sub-stations.

The New Power Station at Saut-du-Mortier, France.—An important central power station has just been completed at Saut-du-Mortier, France, for the distribution of electric energy. The motive power is supplied by the Ain river which at the point of derivation partakes of the nature of a torrent. Its average supply is four cubic meters (141½ cu. ft) per second, but this attains at times seven cubic meters (247¼ cu. ft.). With a minimum supply of 141 cu. ft. the available force would not exceed 600 horse-power. In order to secure a reliable supply of 3000 horse-power, a canal has been constructed which reinforces the river in time of drought by the waters of the Chalain Lake situated about 30 miles distant from the power house, on the left bank of the Ain, from which it is only separated by a deposit of earth. The normal level of the lake being 105 ft. above that of the river at the nearest point and its area being about 500 acres, there is always an ample reserve of water. The station at present contains four units, each direct-driven by a Piccard and Pictet turbine of 700 horse-power. Three-phase 7500-volt Oerlikon alternators are used. Another unit will be installed at an early date. This station furnishes electric light and motive power to the towns of St. Cloud, Orgelet, Arinthod, Oyonnax and several others within a radius of 13 miles.

Explosion of an Enameling Oven.—On July 3 an explosion of rather peculiar origin occurred in one of the enameling ovens of the Richmondt Electric Wire Conduit Works, at Waukegan, Ill. The oven was charged with about 20,000 ft. of conduit pipe, closed, and the gas turned on at full head. Shortly afterward the gas pressure decreased to such an extent that all of the burners were extinguished except one. About an hour later the pressure was increased and the gas accumulated in the oven and ignited from the one burner that had continued alight. The accompanying illustration indicates the result. The oven was completely demolished and the door of the oven blown through the large door at the end of the building. Two men were covered by the falling brick but were rescued without having sustained serious injury. The contents of the oven were transferred to another oven as soon as they were cool enough to handle, so that the heat was not lost. The moral of the accident is obvious.

The Michigan College of Mines has received from the present legislature of Michigan the largest appropriation in its history. It provides among other things for two very greatly needed buildings. One of these is to accommodate the departments of Civil and Mining Engineering. It will provide mining and hydraulic laboratories and a draughting room, together with lecture and class rooms. The amount allotted for its construction and equipment is $42,500. The other building will be devoted to the department of Chemistry and Metallurgy. The laboratories will be fitted up in accordance with modern ideas of lighting, plumbing and ventilation. Among the laboratories, will be one for metallurgical operations. The amount of appropriation for this building is $35,000.

The appropriation furthermore provides for an addition to the present engineering building, which will take care of the needs of the course in blacksmithing and provision is also made for extending the equipment of the electrical laboratory. The work of planning for the erection of these buildings is already begun, and is being pushed forward as rapidly as possible. It is hoped that one or more of the buildings will be ready by the fall of 1902.

Electric Traction on Italian Railways.—Electric traction on Italian railways is of peculiar interest in view of the fact that Italy is not a coal producing country, while, on the other hand, waterfalls abound. The report of engineers Auvert & Bazen, presented at the last meeting of the Italian Railway Congress, gave some interesting particulars of the transformation of the Meridianal Company's Lecco-Sondrio-Chiavenna system. The lines in question comprise about 61 miles in all and are almost independent of the rest of the system and with special conditions of traffic. Serving Lake Como and the heads of the lines of communication for the engadine and the Haute Valteline, they are favored during summer with a large passenger traffic demanding a first-class service of direct and rapid trains with luxurious furnishings. In addition to this there is a considerable freight traffic; so that both branches have to be fully considered.

In the organization of the service the following points receive special attention: (1). Complete separation of passenger and goods traffic. (2). Radical distinction both as regards composition of trains and rate of fares of through and local services. (3). Formation of trains of a capacity approximate to the needs of the traffic anticipated, augmenting the number of carriages at exceptional periods. The passenger trains represent a weight of 65 tons of which the motor car comprises about 30 tons. The speed with a gradient of 1 per cent may reach 37 miles an hour and with a gradient of 2 per cent about 19 miles an hour. The freight trains travel at a speed of 10 to 20 miles an hour; the motor car is capable of an effort of about 5 tons.

The motive power for the working of the lines on which five passenger and two freight trains may be run simultaneously, is 2500 to 3000 horse-power. The hydraulic power station is near Monbegno, 10 miles from Colico. The head of water is 98 ft. The power station contains three turbines of 2000 horse-power each, direct-coupled to three three-phase alternators developing 1500 kilowatts at 15,000 volts. The primary line at 15,000 volts is run over the entire system and carried on porcelain insulators on the poles with the service lines. The potential of the latter is 3600 volts and the transforming sub-stations are about 6¼ miles apart. The motor cars for passenger trains carry four motors of 75 to 150 horse-power each; the freight train motor cars are veritable locomotives. To obviate interruption of current each motor car is furnished with two trolleys about 6 ft. apart so that one at least may be always in service. The cars are heated and lighted electrically, and all of the stations are lighted electrically, with either incandescent or arc lamps, or both, according to their importance.

ESTABLISHED 1889.

American Electrician,

WITH WHICH IS INCORPORATED

Electrical Industries.

CECIL P. POOLE, Editor.
W. H. ONKEN, Jr., Associate Editor.

Published on the first of each month by the

American Electrician Company,

NEW YORK: 120 Liberty Street.
CHICAGO: Monadnock Block.
PHILADELPHIA: 929 Chestnut Street

JAMES H. McGRAW, President.
A. E. CLIFFORD, Vice-President.
C. E. WHITTLESEY, Treasurer.
E. E. WOOD, Secretary.

Subscription, - $1.00 Per Year.

In the United States, Canada and Mexico.
FOREIGN COUNTRIES, $2.00.

NOTICE TO ADVERTISERS.

Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

IMPORTANT NOTICE.

Intending subscribers are warned not to place subscription orders with persons who cannot show written authority to take such subscriptions and make collections therefor, as the paper will not undertake to fill orders placed with alleged agents acting without such written authority.

Subscribers requesting a change of address should invariably furnish both the old and the new address.

Vol. XIII. AUGUST, 1901. No. 8

The American Electrician has a larger paid subscription list than any other electrical journal in the world.

CONTENTS.

The New Central Station at Wallsend-on-Tyne 377
The New Buffalo Terminal Station of the Cataract Power and Conduit Company, by Fred P. Woodbury 385
Boiler Room Efficiencies, by William D. Ennis, M. E. 388
American Engines for the Glasgow Tramways 390
The Practical Application of Superheated Steam, by Geo. A. Hutchinson 390
The Regulation of Alternating-Current Generators, by A. S. McAllister 392
Abstracts from Foreign Contemporaries 394
Some Recent Electrical Patents 396
The Oil Lamp as Applied to Commercial Photometry, by Edwin J. McAllister 397
New Books 398
Notes 398
Editorial 400
Simple Time Signal Apparatus, by S. M. Kintner 402
Telephone Cable Carriers, by W. S. Henry 403
An Experience with Scale in Blow-off Pipes, by Chas. W. Oliver 403
The Sprague Multiple-Unit System, by Edward Chilton 404
Lessons in Practical Electricity 407
Letters on Practical Subjects 408
Electrical Catechism 410
Queries and Answers 411
Fanless Water-Cooling Towers 412
Successful Operation of the Boston Elevated Equipment 412
New Apparatus and Appliances 413
Some of the Exhibits at the Pan-American Exposition 416
Personals .... Adv. 35
Trade Publications .... Adv. 36
Business News .... Adv. 37

Electrocution.

At intervals about as erratic as the arguments presented, publications of various classes break out in tirades against the use of electricity for the execution of murderers; even members of the technical press have indulged in mawkish twaddle anent the "inhumane" character of this method. This application of electricity is, of course, repugnant to the sensibilities of those engaged in more attractive branches of electrical work, but it seems the extreme of cant to oppose electrocution on the ground of a bare possibility that it may not be entirely soothing and restful to the nerves of a wretch who has manifested a disregard for human life.

◆

The New Plant on the Tyne.

The new power and lighting station at Wallsend-on-Tyne, England, which forms the subject of our leading article this month, presents several features of interest, prominent among which is the rank of the plant; it is the most elaborate power-distributing plant in Great Britain and has enormous possibilities of development by reason of the aggregation of industrial establishments along the banks of the Tyne. A policy that will appear almost perverse, to anyone not hopelessly enamored of the induction motor, is the deliberate use of alternating current for motor supply, notwithstanding the fact that direct current had to be provided anyway. The incandescent service, on the other hand, is supplied from the direct-current mains to "avoid the necessity of keeping the three-phase voltage constant to within 1 or 2 per cent." This reason seems somewhat incongruous in view of the fact that if the incandescent lighting had been done by alternating current and all the motors had been made direct-current, the maintenance of constant alternating voltage would have been perfectly simple and a power factor closely approximating unity could have been easily maintained. The engineers are to be congratulated, however, upon not swallowing the entire camel, hump and all; they did adopt induction motors with variable secondary resistances where anything other than constant speed and continuous operation was required.

The plant bears the impress of British conservatism in the shape of the direct-current three-wire generator outfits, each consisting of two 250-volt dynamos driven by a single engine (the over-all potential of the three-wire system being 500 volts). This equipment, while admirable enough for use where the three-wire system is desirable, could obviously have been displaced to excellent advantage by single 500-volt generators, had the direct-current circuits been used only for motors and the alternating current for lighting, as suggested above. This arrangement, it is needless to say, would have also eliminated the balancing sets used at the various sub-stations, still further simplifying the general system. A statement in the article which is not quite clear is one to the effect that the switchboard ammeters are operated through transformers. In view of the total lack of necessity for such an arrangement, together with the fact that the diagram of switchboard wiring does not indicate it, this would appear to be an error on the part of the author of the article.

A point that might advantageously be copied by American engineers is the provision of a water rheostat for testing purposes. We do not know of a single central station in this country that possesses this simple but enormously convenient appurtenance. But, for that matter (to our discredit be it said), there are few if any generating stations in this country where attempts at efficiency and "condition" tests are made at all.

◆

Superheating Steam.

It would appear from reading the foreign contemporaneous technical papers that some European engine builders are either making more rapid progress than Americans or displaying inferior engineering judgment in superheating the steam used in their engines. In some instances German engineers go so far as to build superheaters to be individually fired, like a boiler, and it would seem that such expense and complication would never be countenanced unless the resultant saving were very great. In a paper abstracted elsewhere in this number it is stated that a compound engine running so far underloaded as to cut off at one-tenth stroke, and using superheated steam, developed 500 horse-power on 11.84 pounds of steam per horse-power-hour. In this case the superheated steam passed through the heating coils of the usual reheating receiver of the engine before entering the high-pressure cylinder, the results being that the receiver steam was superheated 110 degrees and the initial condensation in the low-pressure cylinder was thereby almost entirely neutralized. This result, showing from 20 to 35 per cent less steam consumption than is ordinarily obtained with compound condensing engines, appears to entitle the use of superheat to most respectful consideration.

It has long been recognized by American authorities that superheating is, generally speaking, the most efficient means of reducing the internal heat loss due to initial condensation, and it is well known that initial condensation is one of the most serious of all causes of heat loss. Jacketing is held by many to reduce this form of loss somewhat, and in compound engines it may be (and is) still further reduced by reheating the high-pressure exhaust, in some cases a moderate degree of superheat being imparted to the receiver steam. But superheating the steam before it reaches the engine at all appears to be a much better principle than either jacketing or reheating, because then the heat is uniformly distributed throughout the mass of steam and is applied precisely when and where it is needed in order to prevent condensation. In the past it has been generally held in this country that mechanical difficulties in the way of working pistons, valves and rods at 500° to 700° Fahr. render the use of superheat impractical, and American builders have generally contented themselves with the use of jackets and reheating receivers. The Germans seem to be less easily discouraged.

Sparking at Commutator Brushes.

A point worth remembering about brushes for direct-current dynamos and motors is that a slight change in the span of the brush face will sometimes make a conspicuous difference in the operation of the machine. (By "span" is meant the arc of brush contact on the commutator.) It is well known that the tendency to sparking increases with the self-inductive voltage of the short-circuited armature coils, and that this self-inductive e.m.f. increases with the frequency of commutation, or the rapidity with which the current in a coil is reversed. Furthermore, the tendency to sparking increases with the number of coils simultaneously short-circuited at one set of brushes, on account of the mutual induction between neighboring short-circuited coils. Now the frequency of commutation is directly proportional to the ratio of commutator circumference to brush span, or $c \div b$, so that considering this factor alone, the greater the brush contact arc, or span, the lower will be the frequency of commutation and the better the operation as regards sparking. But the greater the arc of brush contact, the more coils will be short-circuited, and the greater will be the tendency to sparking from that cause. Clearly a compromise between the two unfavorable effects must be adopted.

It is obvious that if the span of a brush contact arc is less than the thickness of one commutator segment, the span or arc can be increased until it covers one segment and almost one insulating strip between segments without increasing the number of coils short-circuited. Such increase in brush span will reduce the commutation frequency without aggravating the tendency to sparking from other causes. Similarly, if the brush already covers more than one segment but less than two—its span being, say, 1½ times that of a segment—its surface can be increased until it covers exactly two segments without increasing the number of coils short-circuited, and with a resulting decrease in self-inductive voltage due to the decreased frequency of commutation. The logical deduction is that the best thickness for the brushes of any dynamo or motor is one that gives a brush span precisely equal to a whole number of commutator segments. If the brush span is only a trifle greater than the thickness of a whole number of segments, it is highly probable that the working of the machine can be improved by reducing the span to that of the nearest whole number of segments, unless the brushes and commutator already run hot by reason of high current density at the contact surface. In this event, the brushes could be changed to cover the nearest whole number of segments greater than the original span with improvement both as to sparking and heating.

Electrical Misinformation.

Few causes have served more effectively to retard what might be termed "popular acceptance" of the industrial application of electricity than the utterly senseless "explanations" of trouble that are frequently ladled out to a gaping public. Only a week or so ago, some trouble on the Metropolitan Street Railway system of this city was accounted for by an Inspector in this ridiculous fashion: "As far as we can find out, the power is all right but the current seems to have gone astray(!). I suppose it is one of those cases where the electric current decides to do as it pleases and not as those who want to use it desire." While a technician may read such rot with a smile of semi-contemptuous amusement, there is no doubt that statements of this character tend to increase the groundless suspicion and alarm with which the general public is prone to regard electrical apparatus and phenomena. The interests of the industry would be much better served if corporation authorities would allow sensible explanations of mishaps to be made by competent employees, and muzzle the ignorant utterances of those who scramble for any opportunity to pose as wiseacres.

A Ridiculous Plea.

It is possible that if the officials of the New York Central & Hudson River R. R. Company could have in any degree realized how it would sound to intelligent ears they would never have resorted to the supremely absurd excuse which they have offered as a reason for not hauling trains through their tunnel by means of electric motors. This excuse is, substantially, that no plan for electric haulage has as yet been proposed which would meet all of the conditions of their present practice. This is quite as puerile a quibble as that of the lady who was opposed to the use of the incandescent lamp because she couldn't heat her curling iron at it. If the New York Central officials do not expect to adopt electric motors until electric traction retrogrades sufficiently to "meet all of the conditions" of locomotive practice as applied to the local shifting of trains, the victims of its tunnel inferno may as well change their places of residence now, or else invest in diver's helmets and air tanks.

It is scarcely necessary to point out that the "conditions of present practice" which seem to be so sacred have developed with the locomotive as their basis, developing at the same time the design of that admirable machine. It is obviously irrational to expect that an advanced means of locomotion shall be modified to fit conditions most of which an intelligent use of such means will render obsolete. Did the locomotive "meet all of the conditions of present practice" when it superseded the stage coach? The New York Central officials would command more respect if, instead of turning their backs on the Baltimore & Ohio, Albany & Hudson and other practical demonstrations of heavy electric traction, they acknowledged candidly their observance of the maxim of policy said to have been declared for their predecessors by William H. Vanderbilt.

SIMPLE TIME SIGNAL APPARATUS.

BY S. M. KINTNER.

Recently while contemplating the installation of an automatic bell-ringing system, in the Engineering Department of the Western University of Pennsylvania, to announce the beginning and the end of the regular lecture hours, the writer had occasion to look up in a rather hurried way the systems that are in use and on the market at the present time, and was surprised to find how complex the most of them were. As the installation we desired was not intended to be by any means elaborate, a simple arrangement which could be installed at a low cost and at the same time would give satisfactory service, was desired. The design adopted for this particular case is described herein as it may be of service to someone else for a similar purpose.

In the instance to which this particular sketch refers it was desired to ring bells at the following hours: 9 o'clock, 9:15, 9:20, 10:15, 10:20, 11:15, 11:20, 12:15, 12:45, 12:50, 1:45, 1:50, 2:45, 2:50, 3:45, 3:50, 4:45. This can be accomplished quite easily by electrical means, by making certain additions to a clock face, or better still, by building a new face for the clock, a clock of course being necessary for any form of automatic device that is to be operated at a certain hour. As the building of a new face was found to be the best in the case cited, this plan will be described. It is necessary to have a clock with a second hand in addition to the usual hour and minute hands, and it is preferable to have a clock that is weight-driven in place of a spring drive, as more weight can be added to give additional driving power.

Having such a clock, a piece of hard rubber is taken and turned to the proper dimensions for the clock face. Then the minute divisions should be marked off by means of a milling machine or a gear-cutting lathe attachment, the same being done on the second circle, and such other marking as is necessary for a clock face added. Next turn up a brass ring, as indicated by B_1 in Fig. 1, another brass ring with a 60-degree sector taken out, as shown at B_2, and still a third ring, B_3, which has a small lug soldered to the bottom of it. The brass rings serve a double purpose, acting as stiffeners to keep the rubber from warping and as electrical conductors and supports for the contact points, *A*, *D*, *E*, *G*, *J*, etc., Fig. 2.

Before describing the details of the contact points it may be well to notice the electrical circuit by which the scheme is carried out. The circuit is opened normally in three places, and is closed only when the hour hand, minute hand and second hand are in certain positions all at the same time. It frequently happens that two of these points are closed at other times than the desired time of ringing, but the third is not until the instant when all three should be. To trace the circuit from the sketch for a particular alarm hour, assume the one indicated in Fig. 2, *i.e.*, 12:50. Starting from the outer ring, B_1, as seen in Fig. 1, to which the contact point *J*, Fig. 2, and all corresponding points are connected, the circuit goes to the ring B_2, whenever the minute hand is in the proper position to connect the two parallel contact points at 12, 3, 4, 9 and 10, Fig. 2. From B_2, Fig. 1, the circuit is carried to B_3 by the hour hand closing the gap, as shown at *A*, Fig. 2. Then ring B_3 is connected to ring B_4 through the contact points closed by the second hand when it reaches the point *E*. The points B_1 and B_4 then form the terminals of the device. These are connected to a battery and relay in a simple series circuit; the relay can be made to operate almost anything that one wishes.

It is easily seen now, to go back to the 12:50 example, that the device will operate in about four seconds, or as soon as the second hand brush, *F*, arrives at the point *E*, the circuit being already closed at *A* and *G* by the hands upon their contacts. By the time the second hand makes another revolution the minute hand will have moved off its contacts at *G*, and when the minute hand arrives at 12 for any hour other than 9, the hour hand points will be open.

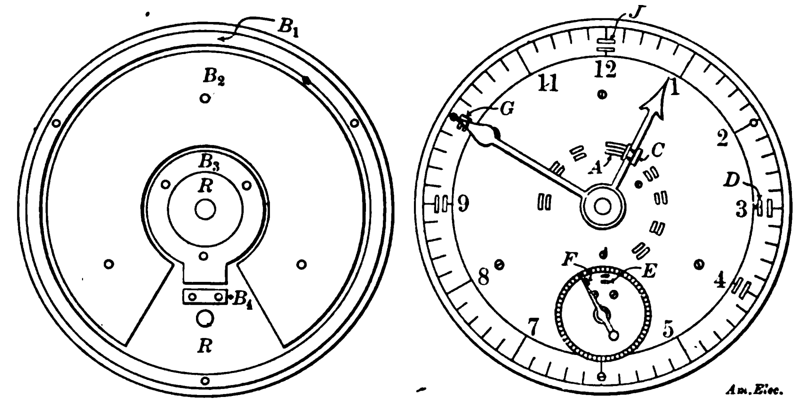


FIG. 1.—REAR AND FACE VIEWS OF CLOCK DIAL.—FIG 2

This produces a very flexible system upon which almost any arrangement of signals can be operated, and with a certainty to within one second of the time as a maximum variation. By the addition of another hand to the clock, a day hand arranged to close the circuit in series with the other three, this arrangement can be made to run a different programme of signals on different days, if that be desirable.

The contact points should be small platinum wires bent to the shape of staple tacks and pushed through two small holes from the front and soldered to the brass rings at the back; the length of each of these contacts is calculated according to the length of time the hand is to stay on the contacts. The minute-hand contacts must all be less than one minute in length, as measured along the minute divisions. The hour-hand contacts between 12 and 1, for this particular case, must be of sufficient length so that the hour-hand brush remains on them for 35 minutes.

As the circuit is always broken at the contacts of the second hand, all the sparking will come there and all renewals will be made at that point; however, by the use of a suitable relay rendering it necessary to use but a small current, it is not likely that any trouble would be encountered from that cause.

In placing the contacts they must be so located that the brush on any one of the hands will not become engaged with the contacts of any other of the hands. This necessitates placing the hour-hand contacts in a small circle, as otherwise the hour hand could not pass over the seconds circle without interference.

The second hand must be insulated from the framework of the clock, as otherwise the apparatus would ring every time the second and minute hands were simultaneously on their contacts, regardless of the position of the hour hand. This would be caused by a shunt circuit through the clock works. There is no danger of the other two hands having any shunt circuit if the second hand is insulated, as the circuit would always be opened at that point. The contacts that are attached to the hands can be made of any light spring material tipped with platinum so as to insure good contact.

The details can be altered in quite a number of ways, and possibly to some advantage for some particular purposes, but this method of having the three open circuit points in series and arranged on the clock face is the simplest of which the writer has any knowledge.

◆

Salt for Pole Preservation.—Mr. R. F. Hayward, chief engineer of the several transmission plants owned by the Utah Light & Power Company, Salt Lake City, has experimented with several plans for the preservation of poles below the ground line. The most successful of these has been found to be a liberal application of salt around the pole while the dirt is being filled in and tamped. Salt is cheap at Salt Lake City, or of course the scheme would not be feasible. The salt seems to very effectually prevent the rotting, which is very serious in some places around Salt Lake.

TELEPHONE CABLE CARRIERS.

BY W. S. HENRY.

There are various ways of stringing telephone, telegraph, electric light and power cables on poles, but the following method has proved to be quite successful in the hands of some telephone companies. Although the special cable carrier, or cable buggy as it is frequently called, which is described and illustrated herewith, may be well known to many construction men, nevertheless, to the writer's knowledge no illustration or description of it has ever been given in electrical periodicals.

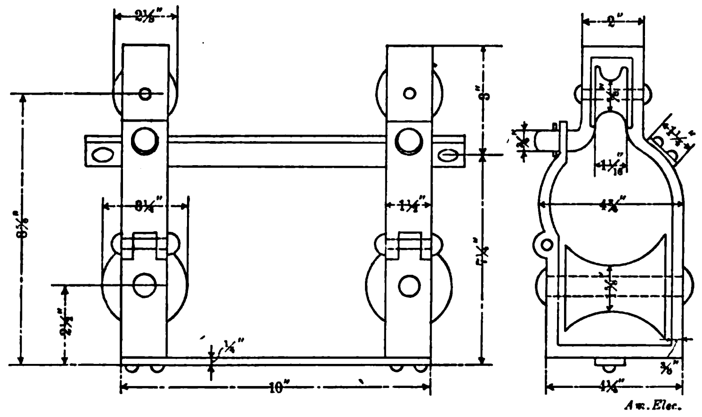


FIG. 1.—SIDE AND END VIEWS OF CABLE CARRIER.

Side and end views of the cable carrier, with all the most important dimensions, are shown in Fig. 1, and an idea of how they are supported on the messenger or carrier wire and tied by ropes to the poles while a cable is being passed through is given by Fig. 2.

The cable carrier consists of four grooved wheels and a wrought-iron framework. Two small wheels fastened in line with each other rest upon the carrier wire and directly below each of these small wheels is a larger wheel. These two larger wheels have grooves made with about a 4-in. radius, so as to readily take without squeezing the largest size of telephone cable, which rests in the grooves as it is drawn along over the wheels. These carriers can be easily slipped over the carrier wire, but when the side bars have been closed the cable cannot fall out of the carrier nor can the carrier fall off the carrier wire.

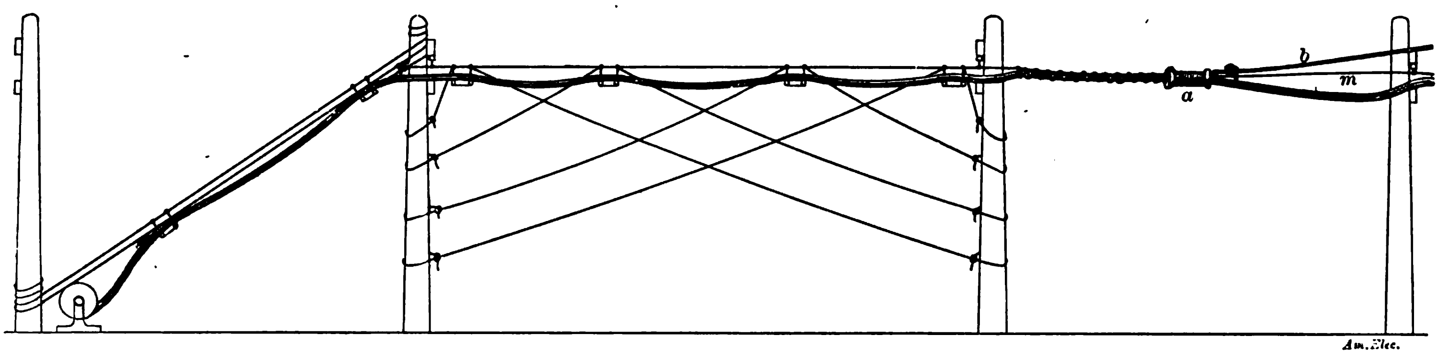


FIG. 2.—METHOD OF BRACING CABLE CARRIERS ON CARRIER WIRE.

One carrier is usually placed on each side of and near to each pole, and one or more additional carriers are placed between the poles; the number necessary will depend upon the weight of the cable and the distance between the poles. Usually there are at least three carriers between adjacent poles. They are held in position by ropes secured to the poles, as shown in Fig. 2, so that the carrier cannot move either way while the cable is being strung. Two of these carriers are generally placed on the guy, or leading-up, wire that leads from an anchor or adjacent pole, near which the cable reel is placed, to the first pole on which the cable is to be supported. Thus, there are two points of support for the cable as it rises to the pole, and this prevents the weight of the cable from the reel to the first pole from producing any tension strain on the cable itself, and also avoids any danger of injuring the cable by too sharp a bend at the first pole.

In order to string the cable a strong rope is passed through all the carriers before they are pulled out into place on the spans, and one end is securely fastened to the cable. The cable is then pulled along through the carriers into position. By placing a carrier on each side of and close to a corner pole the cable can be pulled around the corner without difficulty. After the cable has been strung it is fastened, by the company that uses this carrier, to the carrier wire by wrapping the cable and carrier wire twice in opposite directions with marline twine. For this purpose the Chinnock cable winder is used. This is shown in Fig. 2 at *a*, as it appears when being pulled by the rope *b* from one pole to another. The marline twine slips off the winder and forms a spiral winding about both the cable and carrier wire. The spinning jenny, *a*, as it is called, is made in two halves, these being placed and fastened together near a pole and over both the cable and carrier wire. It is then wound with enough marline twine to wrap the cable and carrier wire from one pole to another. It is next put into position on the other side of the pole and the process repeated. The ends of the marline twine must, of course, be securely fastened at each pole. As fast as the cable is secured to the carrier wire the carriers are drawn to a pole and removed.

The Bell companies seem to prefer fastening the cables to the carrier wires by wrapping the two together with marline twine, while the independent telephone companies generally use cable hooks or clips. The marline twine when worn out can be removed and new marline spun on by men working on the poles without the use of inconveniently tall ladders or the carriage that is otherwise used to carry a man along the line when it is necessary to replace or hook up several cable clips on a messenger wire.

◆

AN EXPERIENCE WITH SCALE IN BLOW-OFF PIPES.

BY CHAS. W. OLIVER.

The manner in which a serious difficulty with scale formation in blow-off pipes was averted in a boiler plant may be of interest to American Electrician readers. The plant consists of eight horizontal return-tubular boilers, furnishing steam for an electric light station, four of which boilers are 48 ins. in diameter. Each boiler was tapped on the under side near the back end for a 2-in. blow-off pipe, and the blow-offs from all the boilers were connected just outside of the settings through globe valves into a 2-in. common waste pipe leading to the sewer. The blow-off connection pipes and valves for the 48-in. boilers were, however, 1½-in., reducing bushings being used at the tees in the common waste pipe and at the ells on the bottom of the short vertical pipes entering the boilers.

The boilers were blown down every morning in order to wash out mud as well as to keep blow-off pipes clean, but much trouble was experienced with the connecting pipes becoming clogged with sediment and small pieces of scale from the boiler, necessitating their frequent removal for scraping. After a long, busy run with insufficient time for cleaning, a blow-off pipe in one of the 48-in. boilers was found to be leaking so badly that it was necessary to shut that boiler down. Upon removing its blow-off connection, it was found that the pipe had been badly burned by becoming entirely filled with sediment and scale, which had baked solid. Then the 1½-in. connecting pipes were displaced on all the 48-in. boilers by 2-in. pipes, the 1½-in. globe valves being also changed for 2-in. valves. But the scale continued to form as before, causing continued trouble and loss of time in removals for cleaning.

Finally, a plan was adopted which avoided further trouble entirely. The globe valve in the connecting pipe was replaced on each boiler by a gate valve, and the connection to the common waste pipe was changed from the original tee to a cross, the one free outlet of the cross being closed normally by a plug. The top of an old globe valve was turned and threaded to fit into the plugged outlet of the 2-in. cross, and in place of its usual valve stem, a long rod having a handle on one end and a slight bend or hook on the other end was inserted.

Then, when a blow-off connection became clogged with scale, the valve top with the hooked rod in it was inserted in place of the plug in the free outlet of the proper cross and screwed in tight, after which, by closing a valve in the sewer connection of the common waste pipe and opening the blow-off gate valve, the cleaning hook could be run forward into blow-off connection while pressure was on, without interfering with the boiler in the least. With a few turns of the cleaning rod, the hook on its end would loosen up all the scale thoroughly, after which the cleaner could be withdrawn and the scale blown out clean.

The blow-off connections were afterward wrapped with several turns of sheet asbestos, which very materially reduced the baking of the scale and sediment accumulating therein. This cleaning device was used with complete success for some time, until a feed-water purifier was installed, which rendered it of little use.

◆

THE SPRAGUE MULTIPLE-UNIT SYSTEM.

BY EDWARD CHILTON.

SAFETY PROVISIONS.

The master controller has three positions, but only two marked notches; these do not include the "off" position. When the master controller handle is in between the two lugs on the motorman's side of the controller top, the controller is at the "off" position; none of the master-controller fingers makes contact, the reverser drum and main controller drum are at the "off" position—all circuits are "dead" in the sense that no current flows through them; but one circuit is very much alive in the sense that a person can easily get a shock from it, if the proper conditions prevail.

The circuit through the pilot motor always begins at the right-hand switch, *L*. Whether the motor circuit carries a current or not, of course, depends upon the position of the master controller, but this does not determine whether certain parts of it are alive and liable to grounds or not. As long as the right-hand switch, *L*, is closed, the path, *L*, fuse, 16, 16, 16, B', $15, P, 17, F \left\{ \begin{matrix} 10, 10, 18, 18 \\ 14, 14 \end{matrix} \right\}$ is always alive up to points 18 and 14, and anyone touching any part of the motor circuit from *L* to 18 or 14 will get a shock, if any part of the body touches any grounded part of the car at the same time. Such a connection made with a screw-driver or other metallic instrument will cause the pilot motor to start if the connection is on the negative side of the pilot motor, but will simply blow the pilot-motor fuse if the ground is in such a place as to cut out the motor. If the ground is on the 10, 10, 18, 18 part of the circuit, the No. 10 part of the motor field is thrown into action and the main motor controller is run on; but the car cannot start, because the main motor circuit is broken at the reverser. If, however, the ground is on the 14, 14 part of the circuit, the No. 14 part of the motor field is put in action and the main drum is run "off," unless it is already "off" as far as it can go. If the main drum is already "off" as far as it will go, the motor and resistance 16 simply heat. Although the first position is not marked, the motorman can feel it when passing it. It is a transition position where the reverser drum is thrown to a running position, to be ready for the first notch.

On the first notch (second position) the interference lug on the controller top stops the handle, and to pass this position a spring button on the handle must be pressed, in order to withdraw a latch that does the interfering. As stated before, on the first notch the *B* relay goes into action and gives the pilot-motor cir-

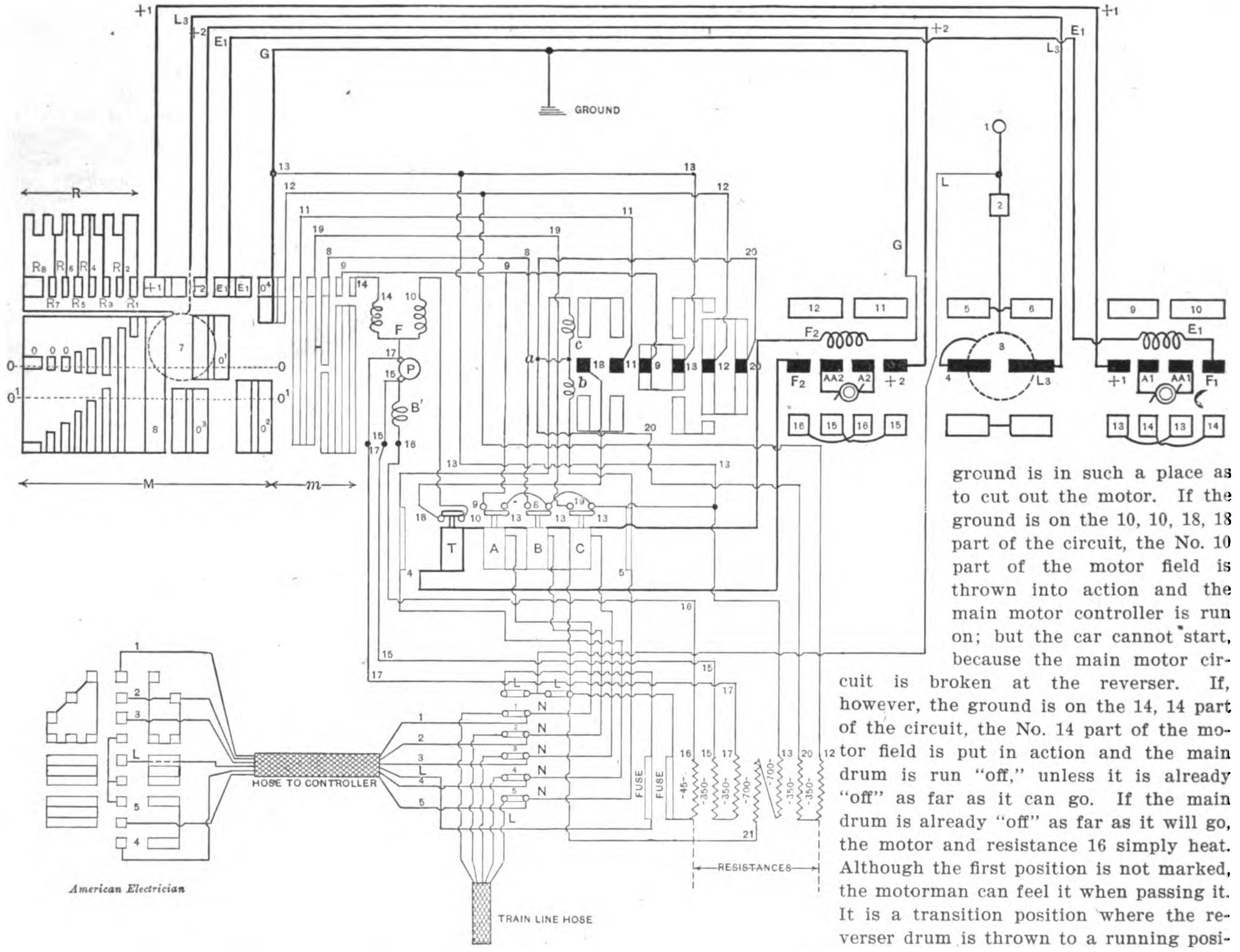


DIAGRAM OF CONNECTIONS, SPRAGUE MULTIPLE UNIT SYSTEM.

cuit a ground, so that the pilot motor runs the main drum up to its last series notch, at which point the pilot-motor circuit is interrupted and the motor stops.

On the second and last notch the *B* relay coil has dropped its disc, but the *C* relay coil has picked up its disc, once more giving the pilot-motor circuit a ground, so that the motor can run the main drum up to the last multiple notch. As soon as, or a little before the last notch is reached, the pilot-motor circuit is once more opened and the motor stops.

The *A* relay coil lifts its disc only on the first notch of the master controller, because only on that notch can the relay coil get any current with which to lift its core and disc. Whenever the master controller is on the first position, the *A* relay coil gets current through path *L*, 1, 1, 1*N*, *A*, 21, 13, 13, 13, 13, *G*, and lifts its disc, short-circuiting posts 9 and 13, and giving the motor circuit a ground, so the motor can run. When the master controller is advanced from the "off" position to the first position, the relay coil, *A*, of course gets current and lifts its core and disc, short-circuiting posts 9 and 13; but the pilot motor cannot start, because the main drum is at the "off" position, and in this position the pilot-motor circuit is opened at finger 14. If, however, the master controller is on the first or second notch, and the controller handle is released by the motorman and allowed to fly back, it goes back as far as the first position and stops there on account of the interference between the controller handle and the lug on the controller top. The relay coil, *A*, immediately picks up its core and disc and closes the break in the motor circuit between posts 9 and 13. Since the main controller drum is now at an "on" position, fingers 9 and 14 are making contact with the drum tips opposite them, so the pilot-motor circuit is complete through field 14 and the drum is quickly run to its "off" position, where the motor once more stops.

Now it is very necessary that the device for running the main drum to the "off" position should be infallible, for the sticking of the main drum at an "on" position would be very serious and probably dangerous. The relay devices, *A*, *B* and *C*, are of the simplest possible construction, and all wires involved in their connections are well protected so that the chances of sticking or open circuit are small. However, to guard against the possibility of the motorman's returning the master-controller handle to the "off" position from an "on" position so quickly as to drop the disc of the *A* relay and open the pilot-motor circuit, stopping the motor before it has had time to run the main drum to its off position, a supplementary wire is used which insures that the main controller drum shall be run to its off position even if the motorman, while the master controller is on the second notch and the car motors are in full multiple, should quickly throw the master-controller handle back to the "off" position.

The supplementary wire referred to is the wire 9, 9, in the diagram, running from the reverser pilot-motor finger No. 9 to the wire that runs from the main controller pilot motor No. 9 finger to the No. 9 relay post. If, while the main drum is at an "on" position, the master-controller handle be allowed to fly back against the post, master-controller finger No. 1 is brought into action, and current passing through the relay, *A*, lifts its disc, closing the motor circuit and allowing the pilot motor to run the main drum to the "off" position. In case, however, the motorman, instead of letting the handle fly back to the post, brings it directly to the "off" position, then the pilot-motor circuit is interrupted before the motor can run the main controller drum to the "off" position.

It is not hard to see that if no means were provided for running the main-controller drum to the "off" position, the motorman might sometimes throw the master-controller handle to the "off" position too quickly, thereby leaving all of the main controllers on the train on their "on" positions (the main motor circuit being open at the reverser drums), with the result that upon putting the master controller on the first notch the next time, the car motors take current with perhaps little or no resistance in the circuit. Such an alarming condition cannot, however, well obtain; the supplementary wire, 9, 9, referred to above, prevents it. Even though the master controller be thrown to the "off" position, current from the right-hand trolley switch, *L*, can still find its way through the pilot motor to run the main drum to its "off" position. The path of the current in this case is *L*, fuse, 16, 16, 16, *B'*, 15, *P*, 17, *F*, 14, 14, 9, 9, 9 (the No. 9 reverser finger), 13, 13, 13, to *G*. When the main drum reaches the "off" position this current path is opened.

Referring to the diagram, suppose that the No. 1 master-controller finger is bent, broken or blistered so that the *A* relay coil can get no current when the master-controller handle is let fly back against the post; or suppose that the disc of relay *A* fails to make good contact even when lifted to its place. In this case the main controller drum cannot be run to the "off" position on the first position of the master controller. If the trouble is in the master controller, every car in the train will be affected, but if the trouble is in the *A* relay coil, only the car on which the defective relay is located will be affected. Thus it can be seen that disorder with a No. 1 master-controller finger is a very serious disorder, as it affects every car on the train when that particular controller is in use. If the motorman finds (from the jerking of the train at starting) that the main drums are not being run back to their "off" position, the best thing he can do for the time being is to throw the master-controller handle to the "off" position, thereby giving the supplementary circuit a chance to run the main drum to the "off position.*

No train should be allowed to remain in service when any of its controllers is in such a condition, for it is absolutely dangerous. Suppose that a crew is coupling on a car, and that the motorman, wishing to kick the car up an inch or two, in order to drop the coupling pin in, gives the main controller what he has a right to suppose is a notch or two (this is done by putting the master-controller handle on the first notch and giving the main drum a chance to run up as far as desired, then letting the master-controller handle fly back to the post)†. If in the previous application the main controller drum has failed to run off, so that it may rest on a notch where part of all of the starting coil is cut out, as soon as the reverser drum moves over to a running position, thereby closing the main motor circuit, the car will start with a jump that is likely to bend the draw-bar or break the drawhead, letting the two cars come so close together as to crush the man between them. It is a good idea, especially where the man that runs the car does not do the shifting, to throw the master controller to the "off" position, if it is not already there, to give the supplementary circuit a chance to run the main drum to the "off" position, thereby eliminating all chances of its being stuck on a notch.*

While the supplementary wire, 9, 9, renders it practically impossible for a car to be left with its main drum on a notch, it does not entirely obviate the bad effects of the motorman's quickly throwing the master-controller handle from an "ahead" position to a "back" position. Whether the main controller drum is run "off" by the circuit provided through the action of the coast relay on the first position of the master controller, or through the agency of supplementary wire, 9, 9, on the "off" position of the master controller, or whether it is partly run "off" by one agency and partly by the other, time is required to do it.

If the master controller handle is thrown from "ahead" to "back" before the main drum has had time to run "off," the main motor circuit is opened at the reverser (that device requiring only an instant to act, which it does as soon as the master controller handle leaves the No. 1 finger on its way to the "off" position) and closed there again, as soon as the No. 1 master controller finger reaches its drum tip on the "back" notches of the master controller drum.* The result is the same as would obtain on an ordinary surface car controller, were the two handles not so interlocked that it is impossible to reverse the car without first cutting the current off by means of the main drum. Assuming that the car is running "ahead" and that the two handles can be operated independently of each other, if the reverse handle be thrown back without touching the main drum handle, the full running current is broken by the reverse switch, which quickly closes the circuit again, but with the motors connected to run in the opposite direction, and the circuit may include none of the starting coil at all; whether it does or not depends upon the position of the main drum at the time of reversal. The result is that full line voltage (and more than this because in sudden reversals there is a period of time during which the counter e.m.f. of the motors adds itself to the line voltage) is applied to the motors, which generate no opposing e.m.f., until the car wheels actually begin to turn in the reverse direction, and which are protected by little or none of the starting coil. The abnormal current that flows is more than apt to blow the main motor fuse, rendering the car helpless as far as the power is concerned; the motor wires are strained, the brushes spark and the strain on the gears is apt to strip the teeth off the pinion.

---

*All possibility of such trouble is done away with in the improved equipment.

†In the improved equipment the controller can be advanced a notch at a time by hand.

*In the improved equipment such a condition cannot obtain.

These same disadvantages to a certain degree attend a too sudden reversal of the equipment which is shown by the accompanying diagram or any other similar equipment. The main controller drum corresponds to the main drum on an ordinary surface car controller and the "reverser" to the reverse drum. On a surface car both handles are moved by hand; on a multiple-unit equipment they are moved electrically. To minimize the chances of serious trouble, however, the multiple-unit equipment has several features not possessed by the ordinary surface car. (1) The reverser being intended to break the main line current under certain conditions, is built on circuit-breaking lines, being substantially constructed, well insulated, provided with numerous breaks and a strong magnetic blow-out coil, so that the rupturing of the mainline current does not burn or blister the parts. (As a rule, the effect of throwing the reverse lever without throwing the current off, on surface controllers, is to burn up the reverse drum and several of its fingers.) (2) The main drum, operating automatically and promptly, will run to the "off" position, if the motorman handles the master controller half-way decently, and prevent trouble. (3) With the connections here shown, and on the improved equipment, the main motors cannot be run past the series connection when reversed.

In the diagram, the coil marked *T* is called the throttle, because it limits the value of the current that can flow through the car motors. When the motors are in series, all of the current that flows through them flows through the throttle coil; when the motors are in multiple, only the current of the No. 2 car motor passes through the throttle. This is all right, because the two motors cannot be so far unlike (and yet run successfully together) that an abnormal main current will not cause an abnormal current to flow through both of them. Ordinarily, the disc of the throttle rests in the position shown in the diagram, where it makes connection between posts 18 and 10, so that the throttle disc is always a part of the pilot motor circuit, as long as the pilot motor runs in such a direction as to run the main controller drum "on." Under this condition, the path of the current through the pilot motor is *L*, 16, 16, 16, B^1, 15, *P*, 17, *F*, 10, 10, 18, 18, 11, 11, 11, to the pilot motor main drum casting; from this casting onward, the path of the current depends upon which relay coil is in use. If relay *B* is in use, the rest of the path is 8, 8, 8, 13, 13, 13, 13, to *G*; but if coil *C* is in use, the path is through 19, 19, 19, 13, 13, 13, 13, to *G*. In either case the pilot motor current must pass through the throttle disc, so that if the disc fails to make contact the pilot motor can get no current and the main drum cannot be run "on." If the pilot motor is running the main drum "on" it can be stopped by lifting the throttle disc by hand; upon dropping the disc the motor will start again. Whether the throttle disc occupies the position shown in the diagram, where it closes the circuit between 18 and 10 so that the pilot motor can run, or whether it occupies a more elevated position, thereby opening the motor circuit between 10 and 18, so that the motor cannot run the main drum "on," depends upon how much current flows in the throttle coil *T*.

Gravity keeps the disc normally in the position shown in the figure. If the current in the coil *T* exceeds a certain predetermined value the disc is drawn up above posts 10 and 18, thereby stopping the pilot motor and the advance of the main drum, until the current reduces to normal value, allowing the weight of the disc to pull it down, re-establish connection between posts 10 and 18, and start the pilot motor again. The throttle can be adjusted to meet either of two requirements. First, the weight of its core and disc may be such that only that current corresponding to the safe output of the motors will raise the disc and stop the motor. In this case, if the motors are properly rated, they are never subjected to excessive currents. Second, the throttle may be set to give a required rate of acceleration—that is, set so that a certain time will be required for the pilot motor to run the main drum from its "off" position, up to its last multiple notch. In such a case the desired rate of acceleration must be known and the motor must be so selected that the requirements will not subject them to too much abuse. This is the most common method of setting.

With a properly adjusted throttle it is impossible for a motorman to do any great amount of damage by feeding up the master controller too fast, however strong may be his inclination to do so. The master controller can be thrown from the "off" position right on around to the second notch without discomfiting the passengers in the least, because the main controller drum can advance only just so fast; if it advances any faster resistance is cut out too rapidly and the main motor current, passing through coil *T*, becomes strong enough to lift the throttle disc and stop the pilot motor. As soon as the car speed works up to a value corresponding to the notch on which the main drum rests the current is reduced, coil *T* is weaker, and the disc drops back to its normal position, starting the pilot motor again. In the diagram it can be seen that when the main drum is being run "off," the disc of the throttle *T* is not a part of the pilot motor circuit, because the No. 14 motor field is then in use and its circuit does not lead through the throttle disc. There is little or no reason why the throttle should be operative while the main drum is running off, because the main current is becoming less steadily and the main drum itself opens the circuit.

Great care should be taken to keep the throttles in good order, the core clean and the disc bright; because if the throttle disc fails to make contact, either through the disc being blistered or through the core being stuck, so that the disc cannot fall back to its normal position after an operation, that particular car will be cut out and its motors can do no work toward the running of the train. On the other hand, if the throttle on any car should get stuck in such a way that the throttle coil cannot lift the core and break the circuit between posts 10 and 18, the main drum on that car will run up at a more rapid rate than the main drums on the other cars do, because if the throttle is inoperative there is nothing to stop the pilot motor when the main current becomes excessive, so the drum runs on up as fast as the motor can run it; whereas on those cars whose throttles are operative the drums will be checked as described. The result may be a condition where the main drum on the defective car is on a multiple notch while the main drums on all the other cars are on series notches. It is not hard to see that this would be an objectionable state of affairs, as the defective car would be greatly overloaded. In the Sprague system a very ingenious and reliable device is used to insure that all controllers on a train shall notch at the same time rate. This device, together with the throttle, prevents any car from taking more than its share of the total train load, and insures the several notches being made with firmness and decision.

◆

A Case of Mixed Rotary Converters.—The article on "Starting Rotary Converters," which appeared on page 358 of our July number, was illustrated by two halftone engravings which unfortunately became transposed. The transposition caused a General Electric rotary to be credited to the Westinghouse Company and labeled a Westinghouse rotary as the product of the General Electric Company. The discrepancy was noted, as is so often the case, just too late to prevent its correction before the sheets were all printed. However, as both machines are of sterling character, the only damage done by the transposition was that to our own reputation.

Lessons in Practical Electricity

THE SYNCHRONOUS MOTOR.—PHASE RELATIONS.

If there were no armature reaction and the armature circuit were not self-inductive, the current taken by a synchronous motor would always be in phase with its e.m.f. and the counter e.m.f. generated by the armature would be squarely opposed to the impressed e.m.f. Such an ideal state is represented vectorially by Fig 8, where *E* represents the phase and relative value of the impressed e.m.f.; *V*, the phase and value of the e.m.f. expended in the winding in forcing current through its resistance, and E_c, the phase and value of the counter e.m.f. of the armature. Under such a condition the counter e.m.f. is evidently equal to the impressed e.m.f. minus the resistance drop in volts.

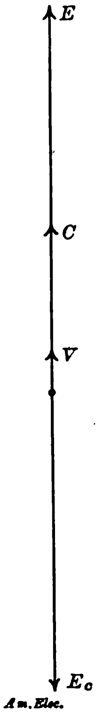


FIG. 8.

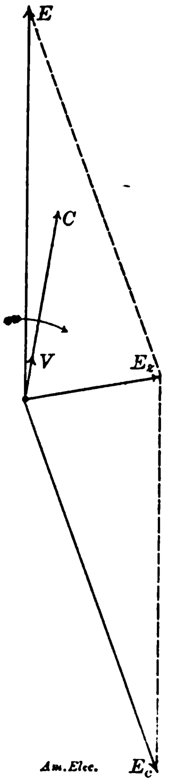


FIG. 10.

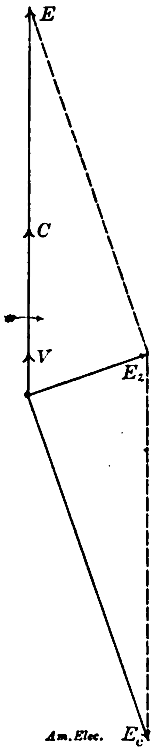


FIG. 11.

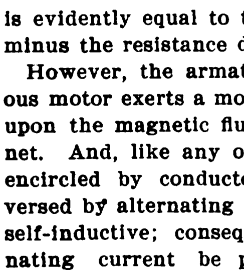


FIG. 9.

However, the armature of a synchronous motor exerts a most vigorous reaction upon the magnetic flux of the field magnet. And, like any other magnetic body encircled by conductors which are traversed by alternating current, it is highly self-inductive; consequently, if an alternating current be passed through the winding it will lag behind its e.m.f. by reason of the reactance of the armature, whether the armature be rotating or at rest. The component of the impressed e.m.f. which is consumed by the resistance of the winding will be in phase with the current, of course, as indicated by the arrow-head *V*, Fig. 9. The self-induced or reactance e.m.f. lags 90° behind the current, so that the component of the impressed e.m.f. which counterbalances this reactance e.m.f. must lie 90° *ahead* of the current, as indicated by the vector, E_x. The resultant of the e.m.fs. expended in overcoming resistance and neutralizing reactance is obtained by the usual parallelogram method; the vector E_z, represents this.

Now the only other e.m.f. that opposes the impressed e.m.f. is the counter e.m.f. generated by the rotation of the armature in the magnetic field exactly as in the case of a generator. The value of this counter e.m.f. depends entirely upon the strength of the field excitation, as in a direct-current machine, but, unlike a direct-current motor, the field excitation and, consequently, the counter e.m.f. do not affect the speed of the machine, because, as explained in a previous Lesson, the speed must have an absolutely fixed ratio to the frequency of the supply current, and cannot vary unless that frequency varies. The result is that altering the field excitation of a synchronous motor not only alters the value of its counter e.m.f. but shifts the phase of that e.m.f., as will be evident presently.

The vector sum of the counter e.m.f. and the impedance e.m.f. (E_z) equals the impressed e.m.f. These two e.m.fs. are combined by the parallelogram method, exactly as in the previous case. Fig. 10 is a diagram showing the combination of the impedance e.m.f., E_z with the counter e.m.f., E_c, to give a resultant equal to the impressed e.m.f., *E*. The curved arrow which crosses the impressed e.m.f. and armature current vectors indicates the direction in which the figure is supposed to be revolving. In the case here shown the field excitation of the machine has been adjusted so that the counter e.m.f. E_c is precisely equal to the impressed e.m.f. *E*. The diagram shows that in this case the armature current represented by the vector *C* leads the impressed e.m.f. to a slight extent. Assuming a constant load on the motor, only a slight reduction in the field excitation would be required to reduce the counter e.m.f. sufficiently to allow the current to come precisely in phase with its e.m.f., as indicated in Fig. 11, where all of the constants forming the basis of Fig. 10 have been retained with the exception of the counter e.m.f.

It will be noticed upon very close inspection that the vectors, *C*, representing the armature current; *V*, representing the resistance drop, and E_z representing the impedance drop, are all a trifle shorter than in Fig. 10. The explanation of this is that with a constant load the amount of current required is less when that current is in phase with its e.m.f., as represented in Fig. 11, than when there is a difference in phase, as in Fig. 10. The power factor of the motor is equivalent to the cosine of the angle between the two vectors, *E* and *C*.

If, now, the field excitation be still further reduced, the counter e.m.f. will also be reduced and the current will lag behind the e.m.f., the extent of this lagging being determined by the extent to which the field excitation is reduced. Fig. 12 shows the condition when the field is weakened sufficiently to allow the current to lag 30°, or 1/12 of a cycle. In this case, the impressed e.m.f. and load remaining unchanged, the armature current is increased considerably, and consequently the resistance drop and impedance drop are also increased, as these vary directly with the armature current.

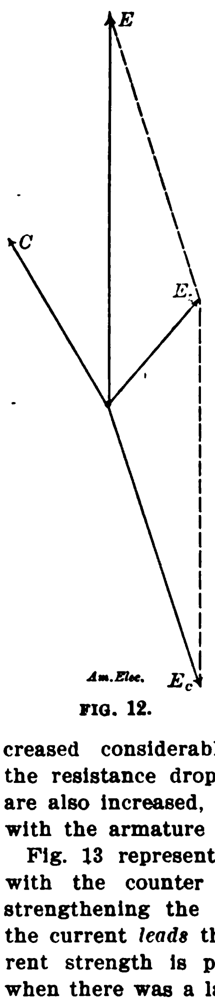


FIG. 12.

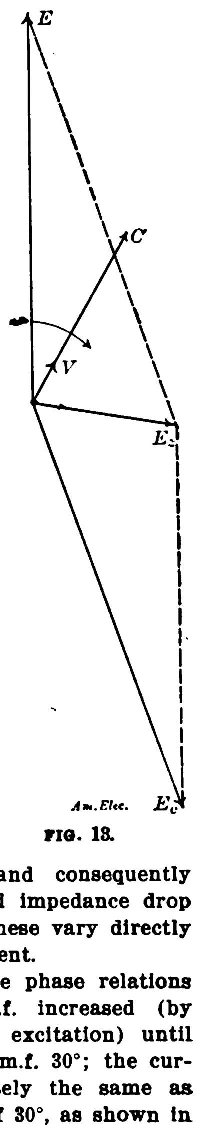


FIG. 13.

Fig. 13 represents the phase relations with the counter e.m.f. increased (by strengthening the field excitation) until the current *leads* the e.m.f. 30°; the current strength is precisely the same as when there was a lag of 30°, as shown in Fig. 12. It is evident, therefore, that with the load constant, if a certain field excitation allows a lagging current of a certain value to flow, a leading current of precisely the same value can be obtained by strengthening the field excitation; or, in other words, there are two values of excitation which result in the same armature current at a given load, and this is true of every load value within the range of the machine.

◆

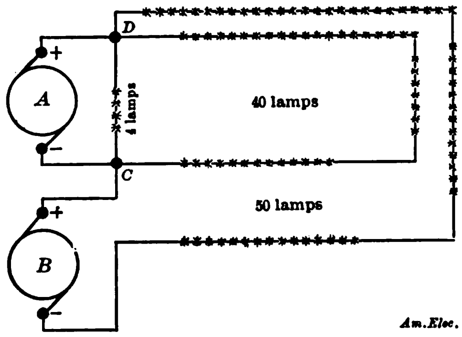
The Twentieth-Century Engine.—In the description of the Twentieth Century engine, which was published on page 367 of the July number, the address of the builders, the Lane & Bodley Company, was erroneously given as St. Louis, Mo., instead of Cincinnati, in which city all steam-engine men know the Lane & Bodley Company to be located.

Letters on Practical Subjects

An Arc-Light Problem.

To the Editor, American Electrician;

Sir:—In regard to the arc-light problem by F. M. Swalm, which appeared in the May number, I offer the following solution. Referring to the diagram, (1) the 40 lamps on the machine, *A*, will be cut out; (2) the four lamps between the crosses, *C* and *D*, will be cut out; (3) the remaining 50 lamps on machine, *B*, will not be affected; (4) both machines will be running in series with *B* doing all of the work.



CROSSED ARC LIGHTING CIRCUITS.

No current would flow across between *C* and *D* providing each regulator worked harmoniously and assuming that each was set at exactly 10 amperes. But the chances of a fraction of an ampere flowing across from *D* to *C*, from machine *A*, are likely, as its regulator may not have wide enough range to cut the current down to 10 amperes under the conditions, and the excess would flow from *D* to *C*.

F. J. Collins.

Waterbury, Conn.

Photometric Measurements.

To the Editor, American Electrician;

Sir:—In the answer to question No. 594 of the Electrical Catechism, published in your May number, an error occurs which you may wish to correct. If I am not mistaken, the word "directly" should be substituted for the word "inversely" in the sentence: "When a balance is found, the strengths of the two lights are inversely as the squares of the distances from each light to the sight-box screen." Of course, the fundamental law of photometry states that "the intensity of light varies inversely as the square of the distance from the luminous point," and it is obviously true that the strength of light in the sight box from either lamp of a photometer varies inversely as the square of the distance from the screen to that lamp, but the function of a photometer is not to measure the intensity of light at the sight box but at the source of the light. It is evident, therefore, that when the sight box is moved to a point where the two beams of light balance each other, the strength of either light at its source is directly proportional to the square of the distance from that light to the screen.

F. Everett Lindsey.

Marlboro, Mass.

Engine Cylinder Cutting

To the Editor, American Electrician;

Sir:—I recently learned of two somewhat unusual cases of cylinder cutting which may be of interest to some of your readers who are having similar trouble and have not been able to trace the cause. In one instance it was found that the boiler feed water contained a small percentage of a light, but gritty, sediment. The quantity was not sufficient to be perceptible, nevertheless, enough was carried over in the steam and deposited in the oil on the cylinder walls to keep the cylinder cutting all the time. In the other instance it was found that piston rings were sometimes worn out in a twelve-hour run; they seldom lasted more than a week, and the cylinder cutting was very rapid. A careful examination of cylinders and piping revealed, in a chamber in the exhaust line, three good-sized pails of sand, and this was traced back to the boiler, the tubes of which, bent while plugged with sand, had not been thoroughly cleaned. When the boiler was put in service the action of the heat and the steam loosened the sand, which was caught in the rush of steam, carried into the cylinder, thence working its way through the exhaust valves, and being deposited in a chamber, where it fell out of the exhaust by gravity.

A. M. Earl.

New York.

The Bucking of Railway Generators.

To the Editor, American Electrician;

Sir:—Referring to the exceptions taken by Mr. Malcolm in the March number and Mr. Morgan in the May number to my article on the Bucking of Railway Generators, which appeared in the February number of your valuable paper, I will say that in regard to the action of the series field in time of reversal, I agree with Messrs. Malcolm and Morgan that the equalizer renders any reversing tendencies of the series field inert, unless the equalizer circuit is defective; and the action of the reversed machine should, therefore, be that of a simple shunt motor. Their point is well taken. The incorrect conclusion was drawn from my oft-repeated experience in running motor-generator tests on two C.-W. machines belted to the same engine, when the equalizer is, of course, not used and where any carelessness in moving brushes or adjusting voltage pays a severe penalty. The error is rectified in my article in the August and September (1900) issues of "Science and Industry," published by the International Correspondence Schools.

In regard to Mr. Morgan's suggestion that dissimilarity of magnetic characteristics may be responsible for flashing at no load, I suggest that it is probably the cause where such dissimilarity exists, but it does not account for this action by machines of similar characteristics, and I can see no other cause than careless handling.

Eugene C. Parham.

Brooklyn, N. Y.

A Problem in Mechanics.

To the Editor, American Electrician;

Sir:—The accompanying diagrams represent a spindle carrying two spherical weights at the extremities of pivoted arms, the structure being very similar to that of the ordinary fly-ball governor. In Fig. 1 the spindle is shown at rest, its weight being borne by the pan of a scale and indicated by the needle of the scale. In Fig. 2 the spindle is supposed to be spinning at such a speed as to throw the balls out to a horizontal position. The question at issue is whether the pointer of the scale will indicate the same weight when the spindle is rotating that it does with the spindle stationary, or less weight. For the sake of argument it is assumed that the rotating spindle is frictionless and that none of its weight is borne by any exterior mechanism not shown. I submit this problem thinking that it may be of interest to a number of your readers who are interested in mechanics.

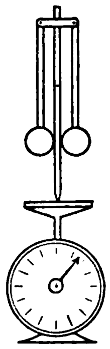


FIG. 1.

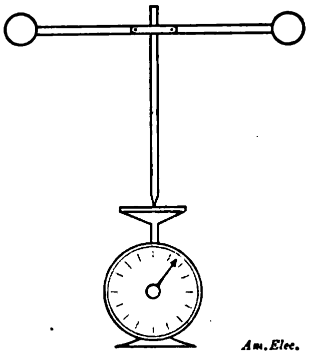


FIG. 2.

Charles H. Holderrieth.

Brooklyn, N. Y.

The Standard Candle-Power of Incandescent Lamps.

To the Editor, American Electrician;

Sir:—Referring to your editorial in the June number on the subject of "The Standard Candle-Power of Incandescent Lamps," I would suggest the following as an explanation of the adoption of 16 candle-power as the standard. It has been found by experiment that one candle-foot—the amount of light obtained at a distance of one foot from a standard candle—is a convenient degree of illumination for comfortable reading. Now, the intensity of light varies inversely as the square of the distance from the source. It follows that in order to obtain a candle-foot at a distance of an integer number of feet, the candle-power of the source must be a square number, such as 9, 16, 25, etc. A 9-c.p. lamp would then comfortably illuminate a table of 6 ft. square (or rather 6 ft. diameter); a 16-c.p. lamp would illuminate an 8-ft. square table, and a 25-c.p. lamp, a 10-ft. square table. It has probably been found that a good-sized family table where electric light is likely to be used is nearest to 8 ft., at least, in one direction; so that may have led to the introduction of the 16-c.p. standard.

Joel Gomborow.

Philadelphia, Pa.

Solutions of Mr. Moutonnet's Problem.

To the Editor, American Electrician;

Sir:—Referring to the solutions of Mr. Moutonnet's problem which were published in June and July, I wish to point out that Fig. 3 on page 309 in the June number is not a correct solution, for the reason that the lamp *A* cannot be lighted alone; no matter in what position the switches may be when closed, both lamps will burn. In the July number, Fig. 4, on page 363, fails to fulfill the requirements of the problem, for the reason that if both lamps are lighted by the switch *C* and put out by the switch *D*, the lamp *A* cannot next be lighted alone by the switch *D*, as the first part of the problem requires when the series of operations is carried through the second time.

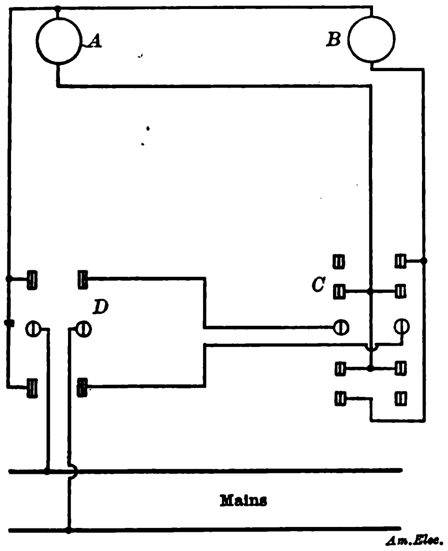


FIG. 3.

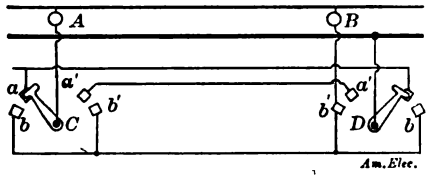


FIG. 4.

Lonaconing, Md. J. S. Jenks.

An Unaccountable Accident.

To the Editor, American Electrician;

Sir:—A very odd accident came within my notice a few days ago which remains yet unaccounted for. We were running a 20 in. x 42-in. Allis simple condensing engine at 92 r.p.m. with 130 lbs. of steam and 26 ins. vacuum. The valves were set for 1/16-in. lead. The engine drives through the medium of a line shaft a miscellaneous lot of electrical generators, including alternating, direct-current and arc-light machines, and was started up about midnight, as usual. Everything ran smoothly until about 5 a.m., when it was noticed that something was wrong. On investigation it was found that the engine had sprung her valve stems exactly alike on both ends, so as to give ¾ in. lead; the exhaust valves remained all right. After shutting down there was no sign of water, mud or any other foreign matter in the engine, and everything was well lubricated. I should like to have the opinion of some of your readers as to the probable cause of this trouble.

Wm. D. Treloar.

Sioux City, Iowa.

Simple Method of Obtaining Two Three-Phase Secondary Voltages.

To the Editor, American Electrician;

Sir:—Referring to the article in July number on "A Simple Method of Obtaining Two Three-phase Secondary Voltages," I wish to say that at the time when the method was originally worked out I was assistant to Mr. R. F. Hayward. Previous to the time when the method was adopted, the 1000-volt system was supplied from a separate set of transformers, with primaries fed from same 10,000-volt bus-bars that supplied the transformers giving 2000 volts. During the winter time, when the lighting load was maximum, it became necessary to in some manner "boost" the 1000-volt circuits, it being impossible to reconcile the two systems, 2000-volt and 1000-volt, with primaries thus supplied from the same bus-bars. No suitable transformers were at hand that could be used as boosters, so the scheme as shown by the diagram herewith was adopted, and gave sufficient increase in voltage. All that was done was to change the primary from "delta" to "star" and connect the two secondary 1000-volt coils in series.

The diagram which I send herewith is the original which I drew at the time. Supplying both systems from the same set of transformers was made necessary on account of the other transformers being required for other work.

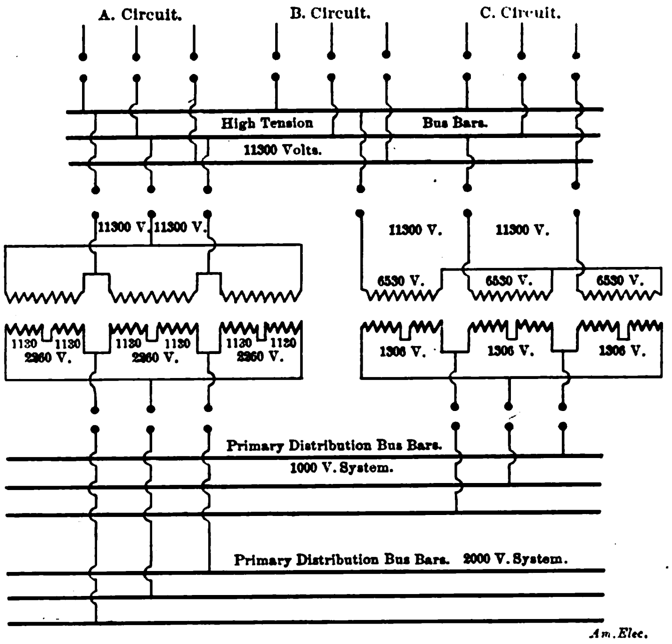


DIAGRAM OF CONNECTIONS.

O. A. Honnold.

Montreal, Canada.

Wanted: A Formula for Tool Handles.

To the Editor, American Electrician;

Sir:—Some time recently I saw published somewhere a formula for the dimensions of tool handles and am unable to locate it. If any of the readers of the American Electrician remember seeing such a formula I will be thankful for information as to where it can be found.

Chicago, Ill. R. M. Gaston.

Diagrams of Telephone Systems.

To the Editor, American Electrician;

Sir:—Some of the independent telephone manufacturing companies appear to be afraid to allow the publication of diagrams of their systems, from which it would appear either that they are ashamed of the systems or are infringing the patents of others; because if a manufacturer really had a good and new system that infringed nobody's patents, it is only natural to assume that he would cover the system by patents and hence have no reason for so secretly guarding it. Many of the same companies manage to get published elaborate descriptions of every new exchange which they install, and all the real information contained in several pages of such descriptive articles could usually be given in less than half a column, and then it would not amount to much. Such descriptions are about on a par with the elaborate descriptions of the Niagara Falls power plants that periodically invade the pages of electrical journals.

The writer knows of telephone users who have put in systems supplied by independent manufacturers, one in particular, and to whom the manufacturer will evidently not furnish a diagram of the system, in spite of the fact that it has been sold outright to the purchaser and the latter necessarily has to keep it in working order. One remedy for such an arbitrary policy would be for telephone users to refuse to purchase any system of which a complete diagram is not given. Personally, I should not install the system of any company that would not give me a diagram of their system, by means of which I could judge of its merits and intelligently install and maintain the apparatus.

The foregoing remarks concerning the

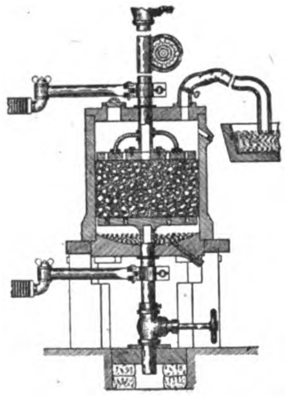
somewhat absurd policy of secrecy apply with considerable force to the Bell manufacturers also. There is somewhat more justification, however, for the manufacturers of Bell apparatus, in that they do not sell excnange and intercommunicating outfits in open market. H. S. Webb.

Scranton, Pa.

Electrical Catechism

622. In what sort of furnace is calcium carbide made?

Several different furnaces are employed, nearly all of them being of the arc type. One of the simplest is that used by Borchers, an eminent German chemist, consisting of two large carbon rods which pass through limestone or similar non-conductor. These rods are separated a short distance and are connected by a small carbon rod which is surrounded by the material (carbon and lime for calcium carbide) to be acted upon. When a heavy current passes, the small carbon rod is heated to incandescence and is burned; an arc then follows and the high temperature fuses the carbon and lime, which then unites as noted in No. 618. The furnaces mostly used in the United States have two carbons arranged one above the other; the upper one is movable vertically and also sometimes horizontally. After the arc is struck the upper carbon is gradually raised as the material below it is changed. In some of the furnaces the arc is maintained at 65 to 70 volts and the current is from 400 to 1000 amperes. To produce one ton of carbide requires about 200 horse-power hours. In some of the furnaces, one of the carbons rotates slowly so as to keep acting on new material.



FURNACE FOR SMELTING GALENA.

623. Are electric furnaces used for other purposes than for making carbides?

The carbides seem to be made more easily than other compounds by the simple heating effect of the current and have been produced on a larger scale commercially. A process is being developed for changing carbon into the form of graphite by means of prolonged heat in an electric furnace. Some graphite is made incidentally in the manufacture of carborundum. The heating effect has been proposed for smelting iron and other ores, the current supplying the heat that would otherwise be supplied by gas or other fire. One of these as arranged for smelting galena or lead ore is shown in the accompanying figure.

624. How is aluminum produced?

Aluminum is made from bauxite, a compound of aluminum, oxygen and water. The ore, which is obtained principally from Georgia and Alabama, is treated by chemical processes to remove impurities and reduced to aluminum oxide ($Al_2 O_3$), commonly called alumina. Aluminum is sometimes prepared from cryolite, sulphate of aluminum and from clay, but in America it is made principally from bauxite. The alumina is dissolved in a bath of melted fluorides of aluminum with sodium or potassium and calcium. This is contained in iron pots lined with carbon which acts as the negative terminal, the current coming in through carbon cylinders or rods in the upper part of the pot. Under the action of intense heat combined with electrolysis, metallic aluminum is deposited in the bottom of the pots while the oxygen liberated from the alumina goes to the positive terminal. About 5 horse-power hours are required to reduce one pound of aluminum. The production of aluminum has increased from 83 lbs. in 1883 to 550,000 lbs. in 1894 and 8,000,000 lbs. in 1898, more than half of the production being in the United States. The price of aluminum has fallen from $250 per pound in 1855 to $0.37 in 1900.

625. What is the difference between aluminum and aluminium?

The two are simply different forms of the same word, the former being somewhat shorter and easier to pronounce. On account of the difficulty in distinguishing between aluminum and alumina as pronounced, the men around the reduction works use the longer word aluminium (pronounced a-lu-min'-i-um) rather than aluminum (pronounced a-lu'-mi-num).

626. What is the relation between chemistry and electricity?

When a current passes through any liquid conductor the liquid is decomposed or otherwise chemically changed, unless it is a chemical element such as mercury or a melted metal. On the other hand, when two conducting substances are immersed in a liquid which dissolves one more than the other, an electromotive force is found to exist between the two. The latter is the basis of all batteries for generating electricity. The former is the basis of the storage battery, and of many applications of electricity to medicine, to chemical manufacture, to electrical measurement, to electro-plating, and many other processes. There is a definite relation between the amount of electrical energy absorbed and the chemical action produced in each case. Chemical action may also be caused indirectly by electricity, as in the electric furnace, where the heating effect of the current causes very high temperatures which loosen the bonds and allow compounds to break up so that their elements may unite in new combinations. This is the basis of electro-metallurgical processes, such as the manufacture of calcium carbide and carborundum. Chemical action, like heat, may thus cause or be caused by electricity.

627. What is a chemical cell or battery for generating electricity?

It consists of two pieces of conducting substances in a liquid that acts chemically upon one more than upon the other. In primary cells one of the substances is generally a rod or plate of zinc, a metal that is cheap and also easily acted upon by solutions of common salts. The other substance is generally carbon, copper or iron. The solution is generally sal ammoniac, copper sulphate or caustic potash. Sometimes acids are used. The conductor that is least eaten by the liquid becomes positively charged and the other negatively charged. In secondary cells the conductors generally consist of lead and its compounds, and the liquid is dilute sulphuric acid.

628. What is the difference between a cell and a battery?

The word "battery" refers strictly to a number of cells coupled together. It is quite common, although inaccurate, to use the word when referring to a single cell. The word "cell" often refers to the containing vessel.

629. What is a voltaic, or galvanic battery?

These are simply other names for chemical batteries. Volta and Galvani are the two men who divide honors for discovering the principle and inventing the battery.

630. For what purposes are batteries used?

Where small currents are used, as for electric door bells, telegraph lines, telephone transmitters, medical purposes and for very small motors, primary batteries are usually the most convenient source of current. Where larger quantities of electricity are required, as for operating electric automobiles, telephone exchanges and for use in connection with central stations for electric light and power, the storage battery has a useful field.

631. What is the difference between a primary and a secondary battery?

When a primary battery is exhausted, it is necessary, as a rule, to throw away the electrolyte and supply a new one; also to frequently renew the electrodes. Storage batteries are recharged by sending a current through them in the opposite direction from that which the battery delivers, the same electrolyte and electrodes being used over and over again. In the secondary, or storage, battery there is no storing of electricity as such. The charging current reverses certain chemical actions, and the energy that is stored is chemical rather than electrical. The only case where electricity is stored as such is in the condenser or Leyden jar.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

Can I change an alternating-current fan motor to run on a direct-current 100-volt circuit? J. H.

No.

How can the direction of rotation of a two-phase motor be reversed? E. S. R.

By reversing the two connections between one phase of the motor and one phase of the supply circuit.

What is the principle of a slide rule? C. H.

The operation of the slide rule is based upon logarithms, all of the scales being logarithmic. In multiplying with a slide rule the instrument simply adds the logarithms of the two numbers which you are multiplying together, and the result on the scale is the logarithm of the number which is actually engraved on the scale.

How can I change the armature of a 100-kw. generator to give 250 volts instead of 500 volts without rewinding the armature? D. C. S.

Take out all of the top connections from the commutator lugs and move each one of them one segment farther away from the other terminal of its coil. The accompanying diagram shows four armature coils after the terminals have been changed as described. You will notice that the terminals of coil No. 1 instead of being connected to segments *A* and *B* or segments *B* and *C* are connected to segments *A* and *C*, one commutator segment intervening between the two terminals connected to the coil. This is true all around the commutator. After changing the connections double the thickness of your brushes, so that each brush will bridge twice the number of segments that it now does.

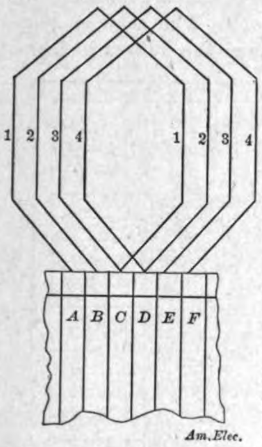


FIG. 1.

What is the maximum height to which a lifting injector will raise water? (2). To what height will a double-acting steam pump raise water? J. L. D.

It is impossible to specify accurately the maximum lift attainable in practice. The limit of lift ranges from 20 to 26 ft., according to the type of injector and the conditions of operation. (2). The theoretical limit of height to which water can be drawn by suction is found by multiplying the height of the barometer by 1.133. The distance to which a pump will actually raise water is, of course, considerably less than the theoretical limit, on account of slip and friction.

Is there any other way of connecting a compound-wound dynamo than the arrangements shown by the accompanying diagrams? A. G.

Yes; your diagrams both show the short shunt connection. The other connection is the long shunt, as shown by Fig. 4 herewith.

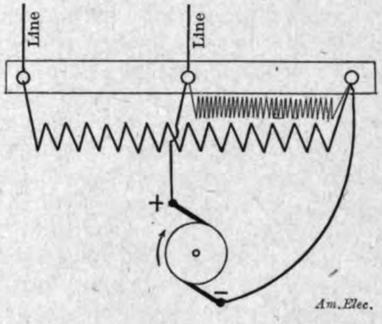


FIG. 2.

How can the clearance in an engine cylinder be equalized without taking off the cylinder heads? A. R. T.

Disconnect the connecting rod from the cross-head and push the cross-head back until the piston strikes against the back head of the cylinder; scratch a mark on the cross-head guide and another mark opposite this one on the cross-head. Pull the cross-head forward until the piston strikes the front cylinder-head and make another mark on the cross-head guide opposite the mark on the cross-head. Then couple up the connecting rod and turn the engine over, adjusting the connecting rod by means of liners in the boxes until the mark previously made on the cross-head comes within the same distance of each of the marks on the cross-head guide at the ends of the strokes.

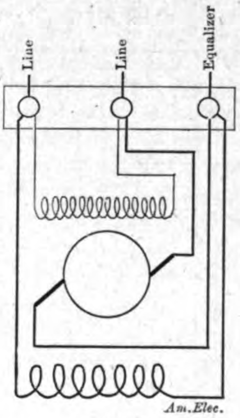


FIG. 4.

What is the advantage of an ordinary single-phase alternating-current system? (2). What is the five-wire system? (3). What is a dead-beat measuring instrument? J. H. D.

The advantage of the alternating-current system over the direct-current system is that service can be delivered economically over longer distances on account of the higher potential which can be used on the feed wires, this potential being transformed down to a low distributing voltage, which cannot be economically done in the case of direct current. (2). The five-wire system is an extension of the three-wire system. There are two main outer wires and three inner or neutral wires. (3). A dead-beat instrument is one whose needle moves promptly to the proper point on the scale without first oscillating back and forth.

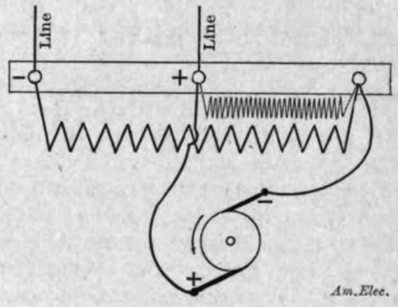


FIG. 3.

In one of Mr. C. E. Knox's articles on "Interior Wiring" he states that the conduit outlet box has openings in the back to receive the wire from the conduit; how are the connections made from the conduit to the box? J. B. F.

The outlet box to which you refer is one used where the conduit is run above the floor beams, as in fireproof buildings or in wood buildings, where the beams are notched for the conduits. Fig. 5 herewith shows how the connections should be made. Where the conduit is run below the beams the outlet box would have openings in the sides instead of in the back.

How can I rewind a 1/6-h.p. 10-ampere constant-current motor to run on a 110-volt circuit? W. H. W.

Connect the machine to a 110-volt current through a rheostat which will stand 10 amperes continuously. Load the machine and adjust the rheostat until the current is 10 amperes and the speed of the motor is normal. Measure the voltage at the terminals of the motor and divide 110 by this voltage; the result will be a number which we will call *K*. Dividing the cross-sectional area of the present field wire by *K* will give you the cross-sectional area of the wire to be used for rewinding the field, and the same process applied to the armature wire will give you the size of the new armature wire. The new field coils must be wound to exactly the same depth in inches that the present coils measure. The new armature coils should have as near as possible *K* times the present number of turns per coil.

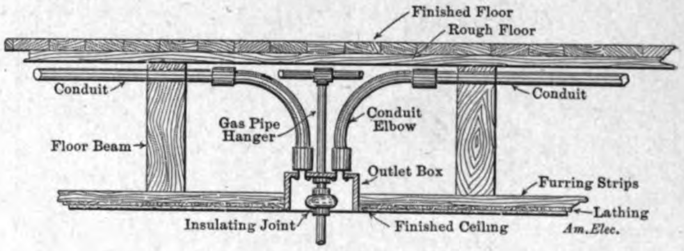


FIG. 5.

FANLESS WATER-COOLING TOWERS.

The use of cooling towers for abstracting heat from the circulating water of a condenser plant has become so general that a description of the process at this date would be superfluous. The construction of cooling towers varies. It is obvious that the best cooling tower is the one which spreads the water out over the greatest amount of surface, so as to obtain the maximum area of contact between the water and the surrounding air. With a view to obtaining this maximum cooling area, fanless towers are built by Geo. J. Stocker, St. Louis, Mo., on the plan indicated by the accompanying engravings.

The cooling tower here shown is built on the lines of the Stocker cooling tower for use in connection with a blower fan, so far as the construction of the cooling surface and the water-distributing system is concerned; the well at the foot of the tower and the space required are also the same, but the fans are rendered unnecessary by the chimney-like extension on top of the tower, which gives the required draft naturally. The draft created within the tower is due, of course, to the absorption of heat by the air, which causes it to rise. It is stated that the velocity of the rising air produces very rapid evaporation, and therefore results in a high cooling efficiency. The cooling surfaces on the interior of the tower are formed by a sort of lattice work of wood strips, arranged as shown by Figs. 2, 3 and 4.

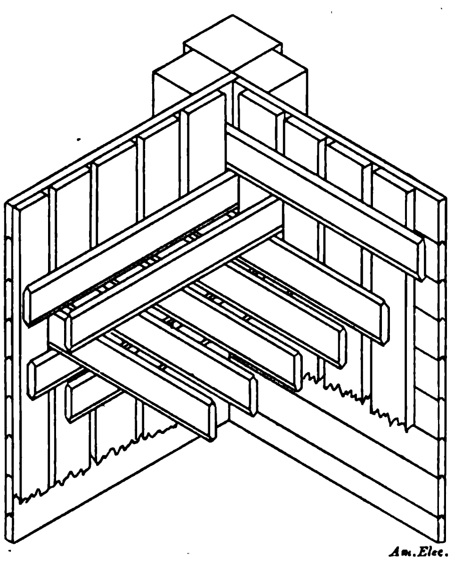


FIG. 2.—DETAILS OF CONSTRUCTION.

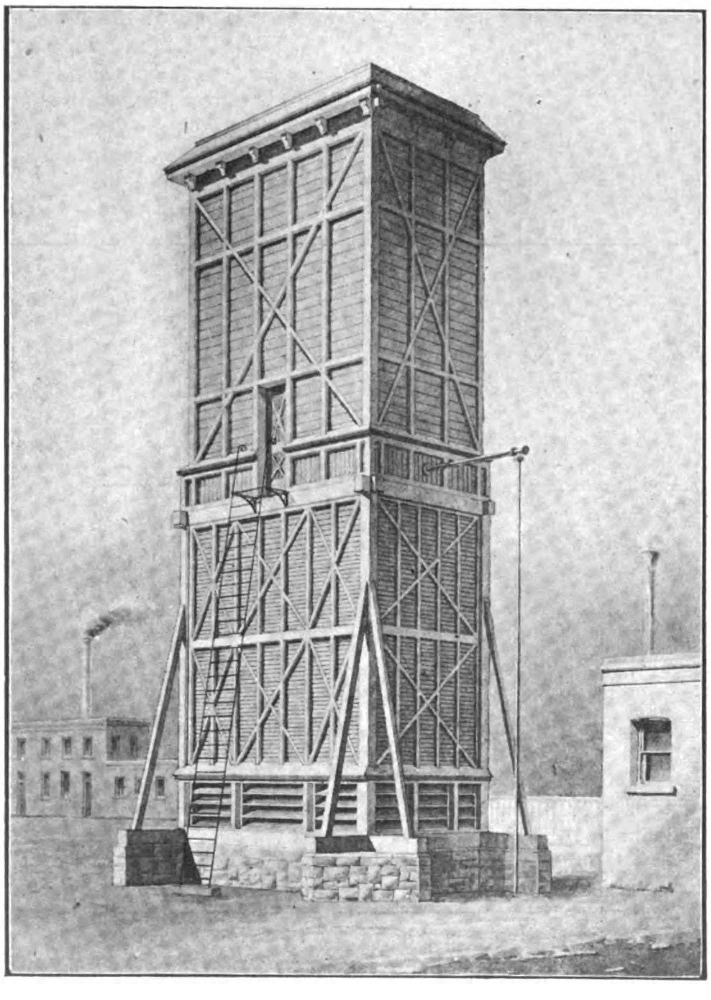


FIG. 1.—STOCKER FANLESS WATER COOLING TOWER.

The water, after being evenly distributed by a system of funnel-shaped troughs, trickles down the cooling surface in a thin film, which is broken up at every intersection of the boards forming the cooling surfaces, and is brought in the most intimate contact with the current of cold air that rushes from below through the tower. The main advantage of the fanless cooling tower is obviously that it eliminates the use of power, which in the mechanical cooling tower is required for the operation of the fans.

Another feature is that the rising vapors condense on the inside wall of the chimney and flow back to the cooling tower. The loss by the partial evaporation of the water running through the tower is consequently avoided. The practical results obtained are said to be very satisfactory. The water entering at an initial temperature of 135° Fahr., is in the average cooled to a temperature ranging from 85° to 90° Fahr., according to the condition and temperature of the air.

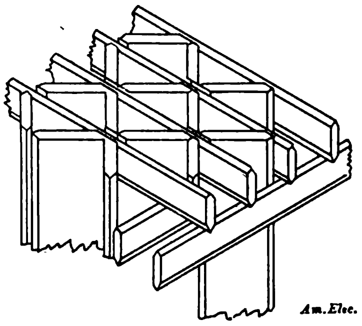


FIG. 4.—DETAILS OF CONSTRUCTION.

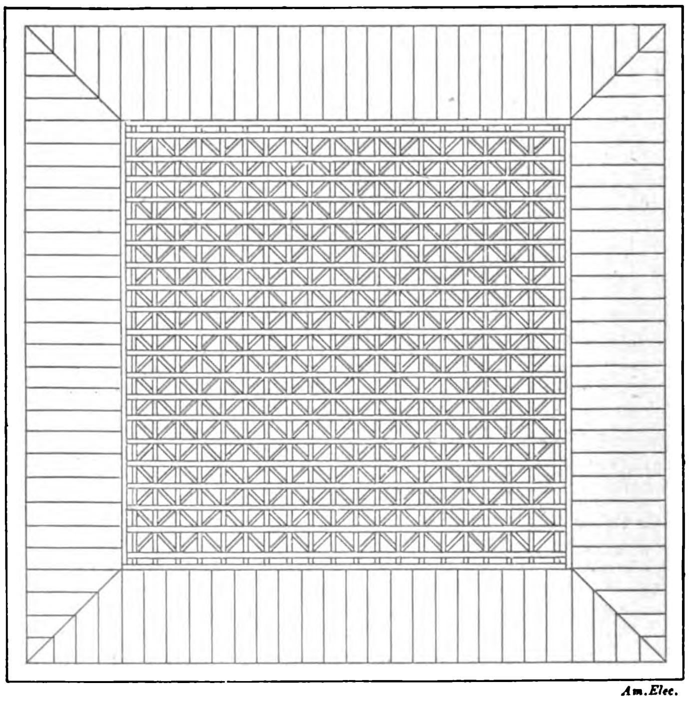


FIG. 3.—PLAN OF LATTICE WORK FORMING COOLING SURFACES.

◆◆◆

SUCCESSFUL OPERATION OF THE BOSTON ELEVATED.

The Boston Elevated Railway Company, which has devoted much time and care to the new electrical equipment of the elevated lines, has had the motors in operation more than a month with very gratifying results. The conditions existing there are most exacting and extremely severe upon the equipment. The Sprague multiple unit system, which was adopted after the most exhaustive tests, is reported to be entirely satisfactory. The service has proven so popular that the 100 cars now in operation have been found to be insufficient for its requirements, and the company has just awarded the Sprague Electric Company a contract for 50 additional multiple-unit equipments.

New Apparatus and Appliances

EVERSHED OHMMETER.

Queen & Co., of Philadelphia, having secured the American rights for the manufacture of the Evershed ohmmeter, are now making a line of these instruments suitable for measuring resistances from 100 ohms to 50 megohms. The set shown by Fig. 1 consists of a direct reading ohmmeter, which indicates by a simple scale reading the value of the resistance being tested, and a portable hand dynamo, or generator, which is wound for 10 to 1000 volts and provides the current necessary to make the test; turning the handle at any speed above 60 r.p.m. in either direction will cause the generator to deliver a constant e.m.f. The astatic soft iron needle of the ohmmeter is magnetized by the current from the generator, rendering the ohmmeter readings independent of the direction of the testing current. The weight of the generator is 15 lbs., and the effort to drive it is very small; the friction in the bearings being reduced to a minimum. In order to minimize the hysteresis and eddy current losses, the armature coils are wound in holes in the periphery of a laminated iron core. The collecting brushes are in the form of elastic discs rolling in contact with the ring segments of the commutator. The gearing between the handle and the armature axle is cut from wrought brass. The handle is held in position for turning by means of a spring catch, and when not in use may be turned back into a recess in the wooden case. A spring drum is provided inside the case on which is coiled a twin flexible cord provided with a connector adapted for clamping under the ohmmeter terminals. When making tests where there are liable to be stray magnetic fields, it is recommended that readings be taken with the generator handle turned first in one and then in the other direction; since if the stray field produces an error, one reading will be as much too high as the other is too low and the mean will be the true value of the resistance.

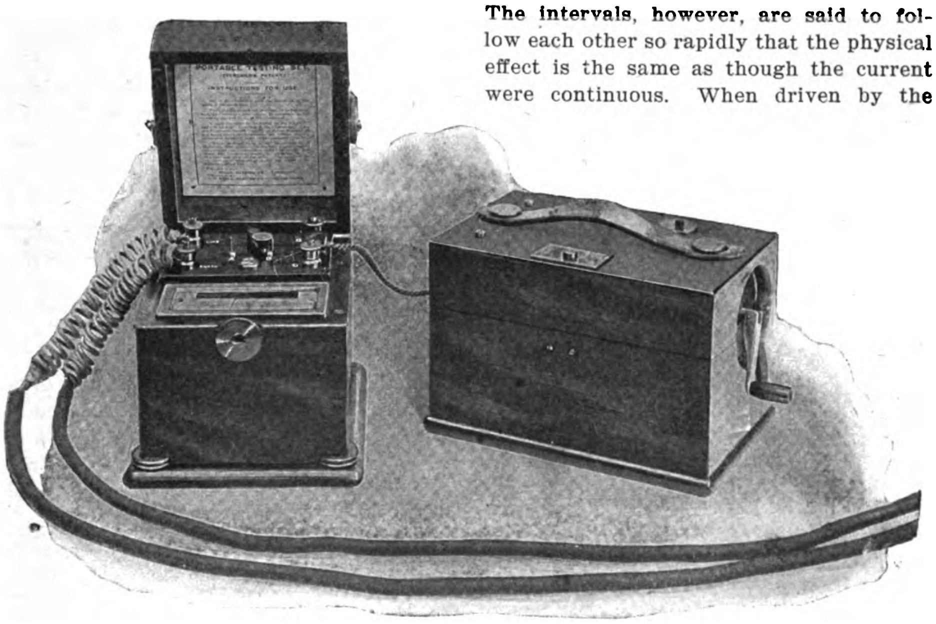


FIG 1.—EVERSHED OHMMETER AND PORTABLE DYNAMO.

GASOLINE TORCHES.

Figs. 2 and 3 show two new torches brought out by the Clayton & Lambert Manufacturing Company, of Detroit. The torch illustrated by Fig. 3 is known as No. 23. It has a flaring tank and burns either gasoline or kerosene. The torch shown by Fig. 2 is automatic in its action. It burns gasoline and is said to yield an intensely hot blue flame free from smoke. The burner is fitted with a needle point so as to enable the user to control the flame. Both tanks are made from heavy brass, and the torches are supplied either polished or nickeled.

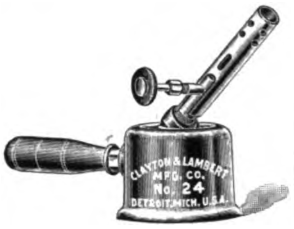


FIG. 2.

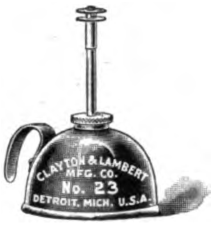


FIG. 3.

NEW TYPE OF CURRENT REGULATOR.

A new type of current regulator known as the rheocrat, and intended to supplant the familiar rheostat for regulating the flow of current is shown by Figs. 4 and 5. The instrument is made by the Erie Exploration Company of New York, and operates by cutting off the current from the translating device for a certain portion of each revolution, so that the current instead of being continuous is intermittent. The intervals, however, are said to follow each other so rapidly that the physical effect is the same as though the current were continuous. When driven by the motor at such a speed that the frequency of interruption is not less than 20 per second, it is stated that no fluctuation or flicker is noticeable on incandescent lamps in circuit. The main advantage, however, claimed for it over the rheostat is that the C^2R loss of the rheostat is absent in the rheocrat, entailing a considerable saving in power consumption. Another advantage claimed is that no adjustment is necessary no matter how many lamps, motors, heaters or other translating devices are switched in or out of the same circuit. The maker also claims that this absolute control of the current by the rheocrat without waste of energy applies to charging of storage batteries or the regulating of current wherever desired. Fig. 4 shows one form of the apparatus. A small motor with just sufficient power to overcome a small amount of friction drives a disc having a brush secured to it on one side and having a stationary brush bearing against it on the other. The movable brush passes over the fixed segments, and by means of a hand-wheel these segments may be coupled at will. If all of the segments are coupled, a current corresponding to the full potential of the circuit will pass through the stationary brush to the disc, and thence through the movable brush to the segments coupled together; finally going to the device with which the regulator is connected. If all but one segment be uncoupled, current will pass only during one-fifth of the time (the

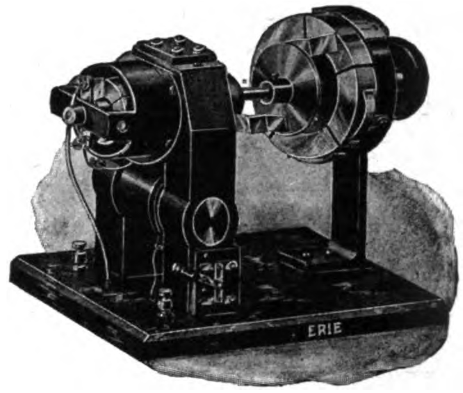


FIG. 4.—ERIE 5-STEP RHEOCRAT.

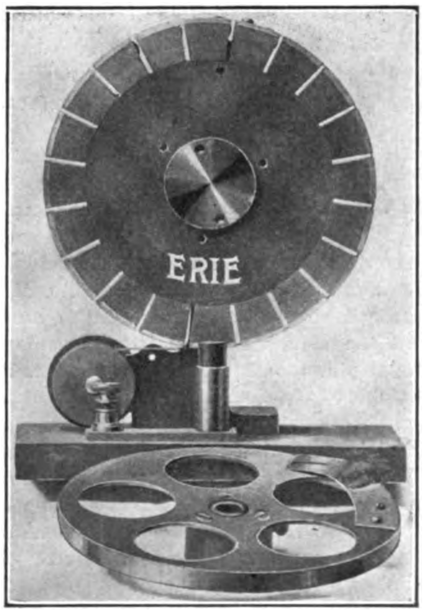


FIG. 5.—ERIE 20-STEP RHEOCRAT.

device having five segments) thus reducing its mean value to that ratio. In order to avoid sparking, a number of small segments are arranged at the point where the circuit is broken, and connected between these segments are resistances arranged so that a series of resistances is introduced in the circuit before it is actually broken.

SEWING MACHINE MOTOR AND REGULATOR.

Fig. 6 herewith shows an ingenious arrangement of a sewing machine motor that has been brought out by the Paragon Fan & Motor Company of New York. An inspection of the engraving will show that the motor is readily attached to any of the leading makes of machines. Besides obviating the foot-power method of operation, it performs, it is said, double the amount of work with entire satisfaction.

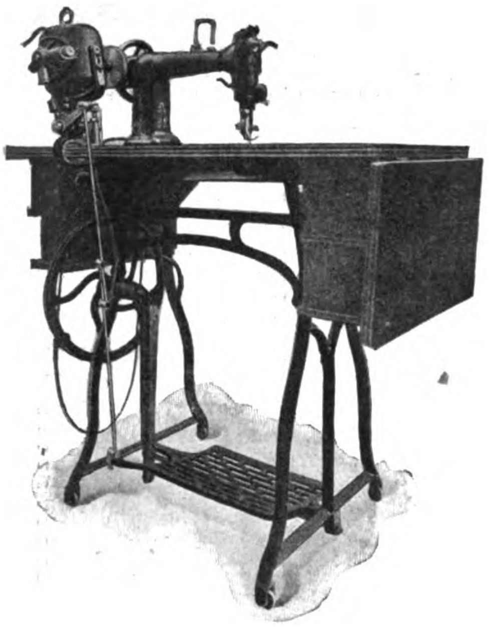


FIG. 6.—MOTOR-DRIVEN SEWING MACHINE.

The motor develops ⅛ horse-power and may be connected to the ordinary incandescent lamp socket.

In order to obtain speed regulation the manufacturer makes use of the fact that a point on the circumference of a revolving disc travels more rapidly than a point nearer the axis. Therefore in attaching the motor to the sewing machine, it is clamped so that the axes of the motor and the machine are in the same horizontal plane, and the friction wheel is adjustable at right angles to the plane of the band wheel of the machine, bearing evenly the whole distance, and with just sufficient friction to start the machine quickly. The motor is free to move to the right or left of the perpendicular, depending upon the motion of the treadle and rod, as shown in the engraving. An adjustable screw limits the movement of the motor on either side; the limit on one side giving a maximum speed, and the limit on the other side being set at a point beyond which the band wheel of the machine would be driven backward. The company claims that the following points should commend it: Absence of belting and rheostat; application to any machine without mutilating the machine; power consumed only with the operation of the sewing machine and in proportion to the amount of work being done and the speed or number of stitches per minute; instantaneous stop "on the stitch" without the use of a brake; variable speed under perfect control of the operator and giving any speed from two stitches per minute to 2000, making it possible to "pick up" the needle a fraction of an inch when desired; prompt start at full speed when desired.

BOILER FLUE-CLEANER ROD.

A common means for cleaning a boiler tube is a brush or scraper attached to a long rod. The rod oftentimes is a length of steam pipe or an iron rod jointed together; but both of these soon become heated while in use, and the jointed iron rod has been anything but desirable. The Butman patent flue scraper rod, illustrated by Figs. 9 and 10, is constructed of rods of tough white ash connected together by a novel ball and socket joint made of steel, which permits the rods to fold in any direction into a parallel group or bundle. The socket holding the brush or scraper is so arranged as to prevent the brush from dropping down when pushed out beyond the far end of a boiler tube; otherwise it would shoulder, making it difficult to withdraw as well as likely to injure both itself and the tube end. The manufacturers claim that the rods are light and stiff, and do not become heated. Moreover, they are of such a diameter as not to cramp the fireman's hands in using them, and can be folded up and put in an out-of-the-way corner when not in use. The rods are made by James McCrea & Co., of Chicago.

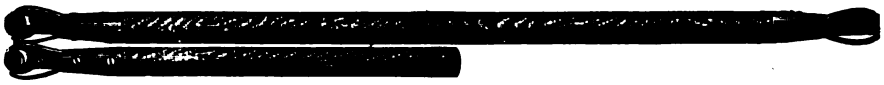


FIG 9.—BUTMAN PATENT FLUE-CLEANER ROD

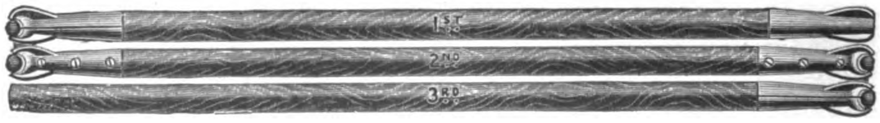


FIG 10.—BUTMAN PATENT FLUE-CLEANER ROD

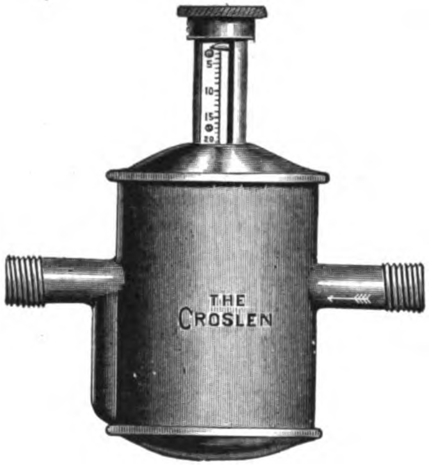


FIG. 7.—CROSLEN REDUCING VALVE.

CROSLEN REDUCING VALVE.

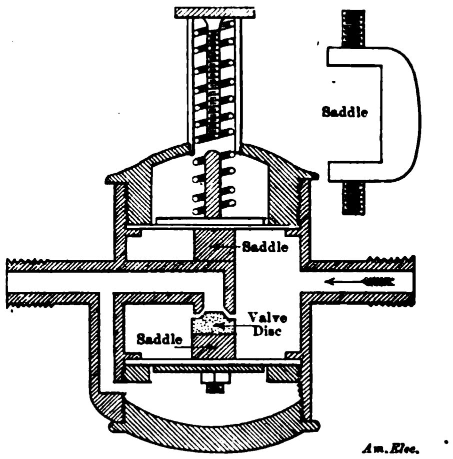


FIG. 8.—SECTION OF REDUCING VALVE.

The Croslen Manufacturing Company, Chicago, is making an extremely simple form of reducing valve, which is illustrated by Figs. 7 and 8. One engraving shows a sectional view of the valve. The inlet delivers steam to a chamber between two diaphragms; these diaphragms being mechanically connected by a saddle or yoke which straddles the end of the delivery tube. A view of this saddle is shown in the upper right-hand corner of the engraving, this view showing the saddle in a plane at right angles to the plane of the sectional cut. On the bottom arm of the saddle is mounted the disc which reduces the delivery orifice according to the adjustment of the regulating spring above. The tube in which the spring is contained is graduated on the outside with a pressure scale, and an indicating finger is provided which shows the pressure for which the valve is adjusted. It is only necessary to turn the thumb screw at the top of the tube until the pointer is opposite the desired delivery pressure. The valve will then maintain this pressure regardless of the initial pressure of the steam or air, this pressure being of course balanced by being delivered between the two diaphragms. The operation will be evident; the pressure of the delivered steam is applied to the under side of the lower diaphragm, tending to close the mouth of the delivery pipe. The degree of compression applied to the spring above the upper diaphragm determines, of course, the extent to which the valve disc will reduce the orifice. These valves are built for air, water, steam and gas.

CABLE-TESTING OUTFIT.

The portable cable-testing set shown by Fig. 11 was designed by Henry W. Fisher, of the Standard Underground Cable Co. of Pittsburg, for tests requiring a strictly portable set. In addition to measurements of capacity, insulation and conductivity resistance, it is possible to locate faults by the Murray and Varley loop tests, breaks in the cables and also to measure the capacity by a new method utilizing a telephone receiver in place of a galvanometer. In order that the apparatus may be operated rapidly and without complicated cord connections, a set of double-throw switches is provided to change the connections from one test to another. The sensitive D'Arsonval galvanometer used with this set has been designed so that it may be used in the laboratory or out of doors as the case may require. The set is manufactured by Morris E. Leeds & Co., whose selling agent is James G. Biddle, of Philadelphia.

SAFETY WATER COLUMNS AND EMERGENCY STEAM TRAPS.

Figs. 12 and 13 show two steam specialties made by the Wright Manufacturing Company, of Detroit, Mich. (formerly of Cleveland, Ohio). The device illustrated by Fig. 12 is an improved high and low water alarm. As will be seen from the engraving, a float actuates, at either high or low water, a lever which causes the alarm to sound. One of the conveniences of the device is that all of the working parts are attached to the cap, so that should repairs become necessary, all that is required is to remove the cap, and all of the parts are accessible. The column possesses also but one vertical valve, and provisions for gauge cocks on either side. Fig. 13 shows the emergency steam trap. Three steam-tight outlet valves are employed instead of one. These valves are placed at the top of the trap, as far removed from dirt, grit and sediment as possible. When the trap is sufficiently filled to raise the float one valve is opened; under ordinary conditions this is sufficient to relieve the trap, but should the water come into the trap faster than one valve can discharge it, the float rises and opens a second valve, and a further rise opens the third valve. A water seal at the outlet pipe prevents the escape of steam.

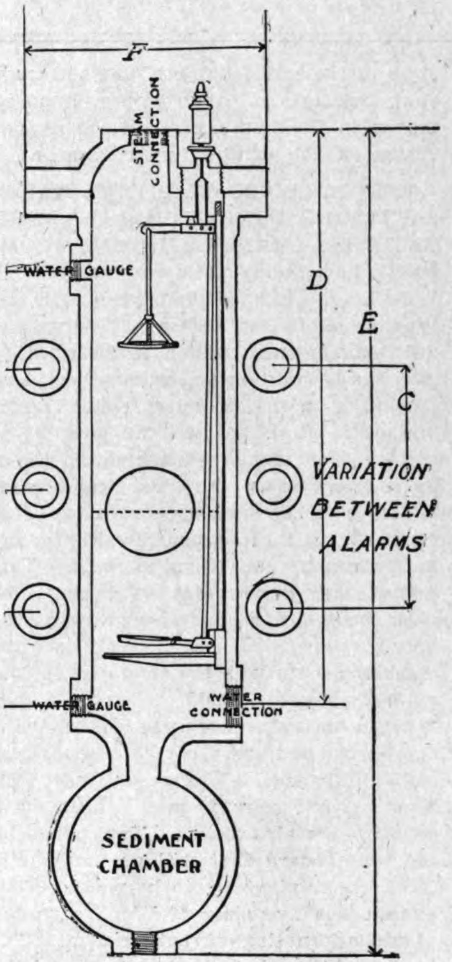


FIG. 12.—SAFETY WATER COLUMN.

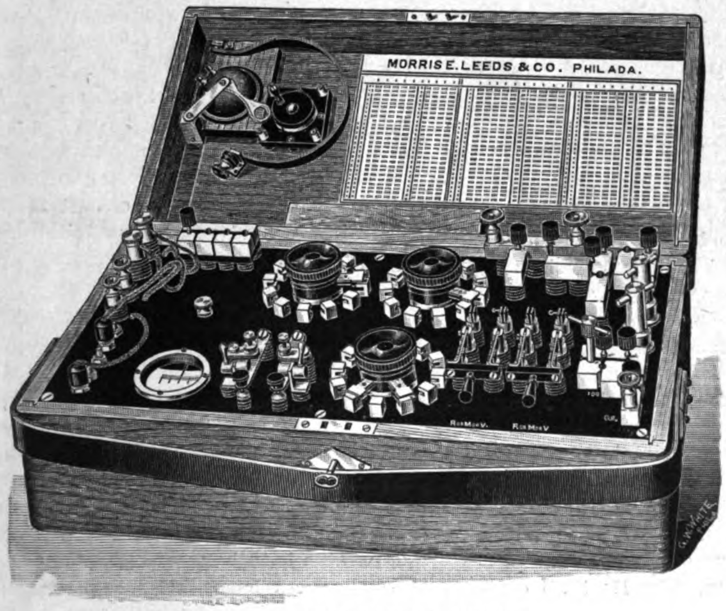

MORRIS E. LEEDS & CO. PHILADA.

FIG. 11.—CABLE-TESTING OUTFIT.

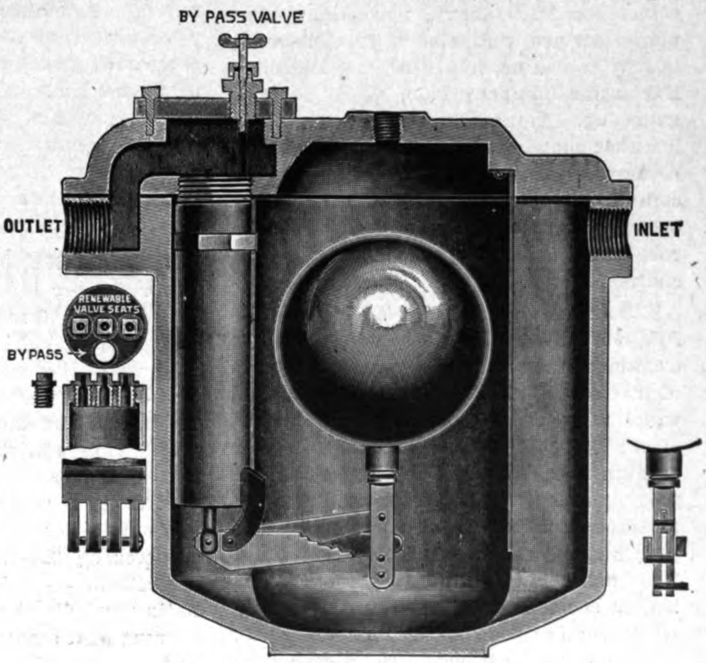


FIG. 13.—EMERGENCY STEAM TRAP.

TURBINE DRIVEN MINING MACHINERY.

Fig. 14 shows two 54-in. McCormick turbines, used for operating a large air compressor and generator in the power plant of the Boston & Montana Consolidated Copper and Silver Mining Co., at Great Falls, Montana. The turbines are each mounted in a separate iron case, and discharge into a cast iron draft chest and plate steel draft tube. The outfit is said to be the heaviest built in America; weighing 300,000 lbs. irrespective of power connections, draft tubes and supply pipes. Both wheels were tested at the Holyoke testing flume, and, it is said, gave unusually high efficiency at part and full gate. Under a head of 40 ft. they develop 2000 h.p. The speed is controlled by a type "B" Lombard water-wheel governor, and the gates are said to be so accurately balanced that one man can operate both wheels with ease. The plant was installed by the S. Morgan Smith Company, of York, Pa.

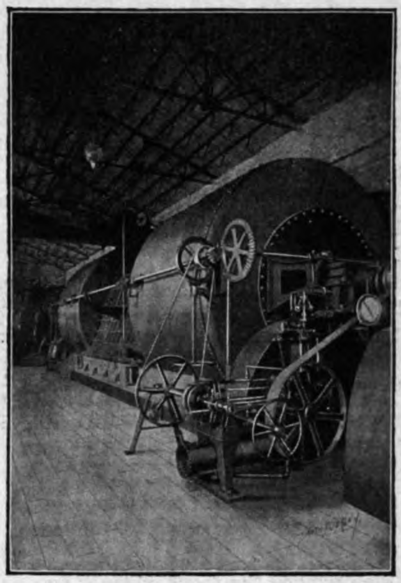


FIG. 14—TURBINES IN MINING SERVICE.

SOME OF THE EXHIBITS AT THE PAN-AMERICAN EXPOSITION

The exhibits in Electricity Building at the Pan-American Exposition are practically complete, although there still remains a little "straightening up" to be done in a few cases before the displays can be regarded as requiring no further improvement.

THE NATIONAL CARBON COMPANY'S booth is of interest not only on account of the great variety of carbons found there, but because the massive pillars and railings of the booth are of carbon made from the regular product of the company. These pillars are electrodes for use in heavy furnace work. The exhibit itself comprises carbons for all uses to which carbon is put in electrical work, including all kinds of arc-lamp carbons, electrodes for gold, silver, copper and aluminum smelting, and for calcium carbide furnaces, carbon brushes of all sizes, battery carbons, electrodes for electrochemical work, telephone transmitter back plates and granular transmitter carbons. Will M. Hoen is the representative in charge.

THE SAFETY INSULATED WIRE & CABLE COMPANY'S exhibit attracts much attention not only from electrical men but from the general public on account of the enormous piece of para rubber gum, said to be the largest ever made, which adorns the front of the space. This piece weighs 1120 lbs., is 4 ft. 9 ins. high and 9 ft. 4 ins. in circumference. In cases set into the back of the space are the rubber-covered wires used by the telephone companies of the United States, cables for army, navy, power and telephone service, and also a case showing all the cables used by the Pan-American Exposition Company from No. 14 B. & S. gauge up. Along the front of the space is a case showing some of the large cables. A short section of the largest submarine cable ever made (25,562,500 circular mils) occupies a place of nonor. Orlando Monroe, assistant general manager, is in charge.

THE NATIONAL AUTOMATIC TELEPHONE COMPANY, of Chicago, shows an exchange in operation between a number of stations. This is an automatic system which requires no operator at the central office; it is applicable to exchanges having as high as 1500 lines, being especially applicable to factory installations. The automatic switchboard shown at the company's space has a capacity for 600 lines. Each subscriber's line terminates at central in a small switch mechanism having 600 possible positions. There are six rows of switch contacts, 100 in each row. A traveling contact is provided for each row. To call a subscriber, a button on the telephone instrument is pressed the number of times that there are hundreds in the number wanted; a pointer on the instrument is then set at the tens and units of the called number, and the traveling contact of the proper hundred moves to the number. O. A. Estes has charge of the exhibit for the season.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY and WAGNER ELECTRIC MANUFACTURING COMPANY have joint exhibits in charge of L. J. Belknap, of the Buffalo office. In the Wagner exhibit is shown a 175-kw. oil-filled transformer, which is designed to give 18,500 volts on the primary coil and 1100 volts on the secondary coil. This is one of 23 to go to the McCloud River transmission plant in Washington. Next to it is a 100-kw. air-blast transformer which is of the same type as a lot of 22 furnished to the Castner Electrolytic Alkali Company at Niagara Falls. This transformer is provided with ducts for both the inflow and outflow of air at the bottom, and the leads are brought into the transformer through the air ducts, so that no leads appear outside on top. It has 14 loops on the primary whereby the voltage on the secondary can be varied from 148 to 181 volts. Wagner standard oil-filled transformers from 25 to 6/10-kw. capacity are also shown. Two panels of the switchboard that will go to the McCloud River plant are to be put up. The exhibit has five sizes of Wagner single-phase alternating-current motors. The largest of these is 30 horse-power, and the smallest ¼ horse-power. All are for 60-cycle current. The 30 and 15-h.p. sizes run at 1200 r.p.m. and the smaller ones at 1800 r.p.m. The Bullock exhibit of direct-current motors and dynamos includes a 150-kw. and a 30-kw. engine-type direct connected generators, two medium-speed belted machines of 50 horse-power and 30 kilowatts capacity, and five sizes of direct-current enclosed motors, from 45 to 2 horse-power. A printing-press controller is included in this portion of the exhibit.

THE LEA ELECTRIC MANUFACTURING COMPANY, of Elwood, Ind., has an important arc lamp exhibit in charge of R. B. Hurst. One of the strong points of this company's line of lamps is that the case over the mechanism is hinged in halves, so that it can be swung back in an instant and the entire mechanism exposed. The miniature lamp this company makes for both alternating and direct current takes 5/16-in. carbons and consumes 2½ amperes on 110-volt circuits or 1¼ amperes on 220-volt circuits; the life of the carbons is 75 hours. The large alternating and direct-current lamps require a current of 5 amperes. The Northall electric headlight for electric railway cars is exhibited for the first time with an attachment whereby the length of the arc may be shortened from 250 volts down to the minimum length at which it will burn reliably. This lamp takes 1½ amperes, though it can be adjusted for various currents. It can also be adjusted to burn in series with the incandescent lamps in the car.

THE CROCKER-WHEELER ELECTRIC COMPANY makes the central feature of its booth a 30-kw. generator made for direct driving. The machine has neither shaft nor bearings; the armature being built for mounting on an extension of the engine shaft. This generator is designed to run at 300 r.p.m. Motors from 3 to 25 horse-power are shown. One of these is a crane motor with rheostat and solenoid brake attachment on the axle. Four sizes of drum controllers for hoists and similar work are exhibited. As a background for the exhibit there is a number of photographs of the Crocker-Wheeler Works and apparatus. A large illuminated sign indicates the location of the exhibit from a distance. R. B. Otis, of J. L. Alberger & Son, engineers, Buffalo, looks after the exhibit.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, of Chicago, makes a very fine showing in its elaborate and handsome headquarters. S. J. Bear designed, installed and has charge of the exhibit. A large central-energy multiple switchboard has been delayed because of rush of business at the factory, but a 100-line Bell-type switchboard, a 300-line cross-connecting board and a 100-line American express board are in place, and a large number of switchboard appliances are shown. A power board is supplied with current from a Roth motor-generator. A handsome case facing the main aisle displays the smaller parts. Twenty-six types of telephone instrument are shown, including central-energy and magneto call instruments for general and special uses. The Warner ringing machine is shown also in this space. This is a substitute for magneto or motor-generator central-office ringing, which consists of a battery of 40 to 60 cells, the circuit from which is interrupted and alternated by a vibrating pole-changer kept going by an Edison-Lalande battery.

THE CUTLER-HAMMER MANUFACTURING COMPANY, of Milwaukee, Wis., has an exhibit of considerable technical and historical interest, which shows not only the best of the apparatus now made by the company, but also illustrates the evolution of the motor-starting rheostat. Ranged along the two sides of the space is the historical apparatus and the modern apparatus is in between. Each of the historical pieces has a brief explanation posted over it. The story begins with the first motor-starting rheostat with magnetic release which was built under a patent of H. H. Blades, No. 418,768, issued January 7, 1890; next to which is a motor starter without magnetic release made by the Thomson-Houston Electric Com-

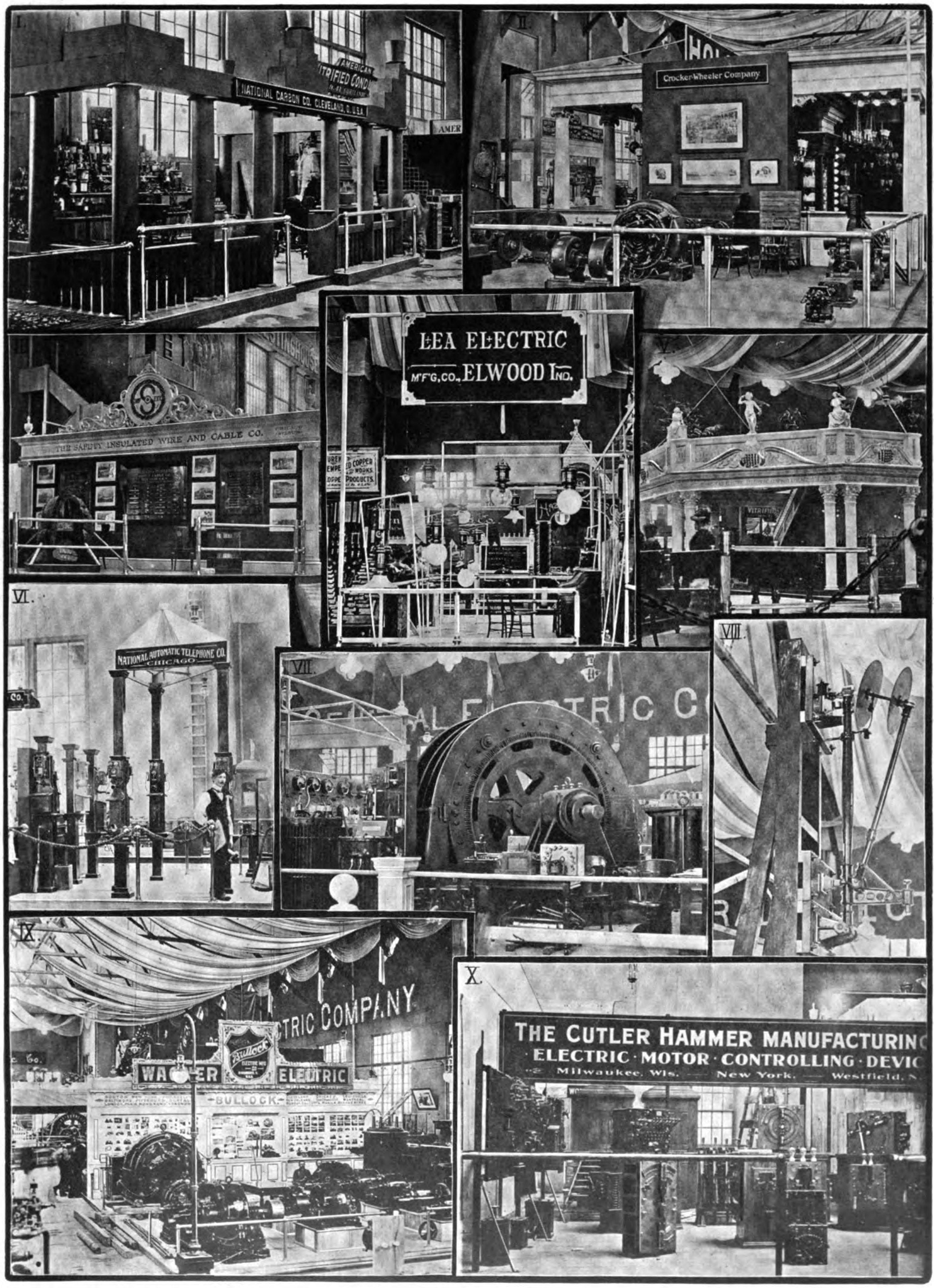

I.
NATIONAL CARBON CO. CLEVELAND, O. U.S.A.
AMERICAN VITRIFIED COND
II.
Crocker-Wheeler Company
III.
THE SAFETY INSULATED WIRE AND CABLE CO.
LEA ELECTRIC
M'F'G. CO. ELWOOD IND.
V.
VI.
NATIONAL AUTOMATIC TELEPHONE CO.
CHICAGO
VII.
RIC C
VIII.
IX.
TRIC COMPANY
WAGNER ELECTRIC
Bullock
BULLOCK
X.
THE CUTLER HAMMER MANUFACTURIN
ELECTRIC MOTOR CONTROLLING DEVIC
Milwaukee, Wis. New York. Westfield, N

FIG. 1.—SOME OF THE EXHIBITS IN ELECTRICITY BUILDING. NOS. VII AND VIII SHOW STANLEY APPARATUS.

pany in 1891. All the earlier rheostats are wood encased. In 1893 appeared the Cutler-Hammer starter with marble front, iron frame and magnetic release, which is very similar to the one turned out by the company at the present day. The collection shows a large number of rheostats of various makes and designs and is very instructive though space limitation prohibits a description or even an enumeration of them all. A variety of time-limit motor starters of present make are included in the exhibit. One of these operates with separate switches for each step, others with one switch handle and a catch on the handle.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has a diversified and extremely attractive exhibit located exactly in the center of Electricity Building, as shown by the plan of that building presented herewith. A view of the exhibit is given by Fig. 2, but this conveys by no means an adequate impression of the character of the apparatus shown. In the center of the exhibit is a 300-h.p. 3-cylinder 4-cycle gas engine direct-coupled to a 2200-volt 2-phase alternator of the revolving-field type. The power from this alternator is employed partly in supplying current to 130 Nernst lamps, which operate at 220 volts; and partly for the operation of numerous Westinghouse induction motors in service about the Exposition buildings. Nearby is a smaller gas engine of the same type, direct-connected to a 125-volt direct-current dynamo which supplies exciting current for the alternator driven by the large gas engine, for lighting the switchboard, and for charging the storage batteries employed for ignition at both gas engines. This dynamo also supplies current to a motor-generator set, and to the lighting circuits of four large electric signs, one at each end of Electricity Building and two in the center. There is also shown a 375-kw. alternator of the revolving-field type, designed for 60 cycles.

The dome of Electricity Building, which is immediately above the exhibit, is tastefully draped with hanging green and lavender bunting, making a background upon which numerous strings of Nernst lamps festoon off from a large 2000 candle-power lamp placed in the center. There are more than one hundred 400-c.p. Nernst lamps in service here, constituting the first public exhibition of this type of lamp in America.

Of transformers there is shown a complete line of the company's O. D. transformer from ½ to 50 kilowatts; two sizes of manhole type transformers, and two 100-kw. self-cooling, oil insulated transformers. The latter are used to transform the e.m.f. of the 180-kw. machine from 2200 to 110 volts, at which potential they deliver current to the four incandescent signs. One of the most novel attractions in the building is a high voltage sign, consisting of two large glass plates covered on the back with metal foil, with the name "Westinghouse" in its center. An alternating pressure of 40,000 volts, maximum, is applied between the foil on the back and the metal letters on the front. As the potential is raised a fringe of violet light appears about the letters which, gradually increasing in intensity, culminates in myriads of branched discharges like lightning that play continuously over the surface of the plate and are accompanied by a continuous crash not unlike thunder.

Among the railway motors included in the railway exhibit are a Westinghouse 56 motor for heavy suburban and interurban service, a 50-C for heavy railway service, and a 69 motor for city and suburban service. These motors are split horizontally with the suspension on the lower half of the field. The pole faces are smooth and unbroken, and the armature winding is ventilated. The 50-C motor is provided with a special cradle suspension from the car axle, which removes the weight of the motors from the truck.

There is also a large number of Type "C" (constant speed) induction motors and of Type "F" (variable speed) motors. The latter are provided with collector rings and secondary leads to an adjustable external resistance for controlling the speed. The company also exhibits a complete line of detail apparatus, including meters, lightning arresters, fuse blocks, switches, circuit breakers, etc.

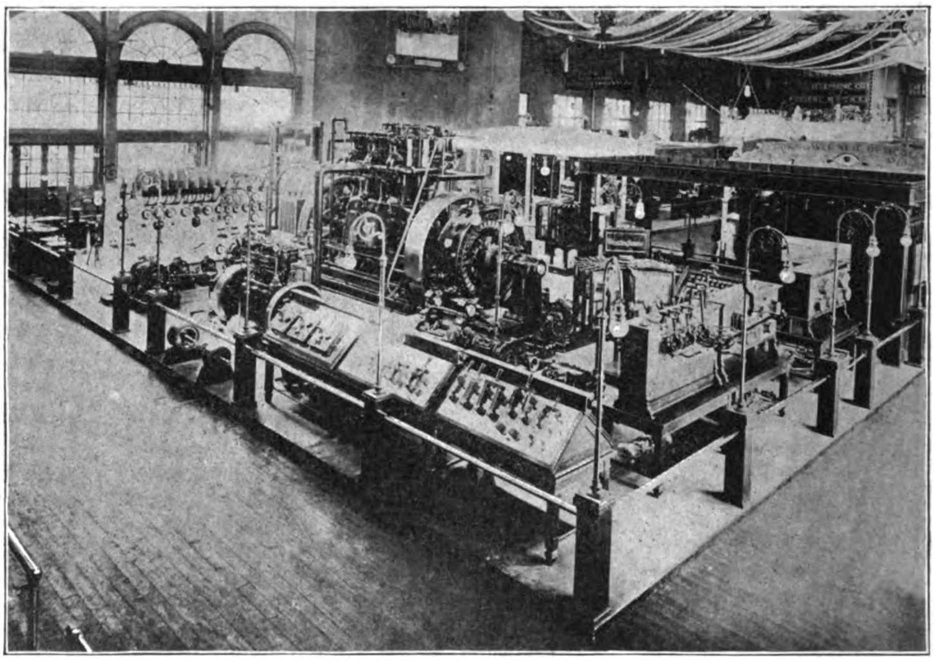


FIG. 2.—WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY'S EXHIBIT.

In the Railway Exhibits Building, at the northern gate of the Exposition grounds, are shown the Westinghouse combined electric brake and car-heating apparatus in full operation. The outfit consists of two elements, a brake and a car heater. The brake may be installed and used independently of the heater, but the operation of the heater is dependent upon the use of the brake, the heat being derived from energy that would otherwise be wasted. The brake is of the combined wheel and track variety. When in action, powerful magnet coils set up a strong magnetic attraction between horizontal brake-shoes and the rails, drawing the shoes down on the rails; the drag of these magnetic shoes throws in action a system of levers that apply brake-shoes of the regular type to the car wheels. The current for exciting the magnets is supplied by the car motors which through the controller are at this time operated as generators.

THE E. G. BERNARD COMPANY, of Troy, N. Y., has a house in the west side of the north basin where its office and reception room is located, and where are two motor-generator sets for supplying the large electric fountain searchlights with current from power supplied by the 500-volt power service. These motor-generators are loaned by the E. G. Bernard Company for the season of the Pan-American.

THE ILLUMINATING APPLIANCE COMPANY, of New York, is a new company recently incorporated for the manufacture of lamp globes under some new patents. This company has a handsome space and the flower effects produced by some of its incandescent lamp shades are very fine. J. Henry Klinck is in charge.

THE HOLOPHANE GLASS COMPANY has a very scientific exhibit and at the same time one that can appeal to the public. The front of the booth has simply a handsome display of holophane globes, but in the rear of this is a photometer room. This has an accurate photometer for the benefit of electrical engineers who may wish to make a test. It also has a photometer which appeals to the practical lay mind. In one end of the dark room is a partition on one side of which a lamp with a holophane globe is placed to be compared with lamps with other forms of globes and shades. The observer at the other end of the room can see both sides of the partition and note the comparative illumination on tables underneath the respective lights. E. L. Elliott, superintendent of the factory at Newark, Ohio, is at the exhibit most of the time.

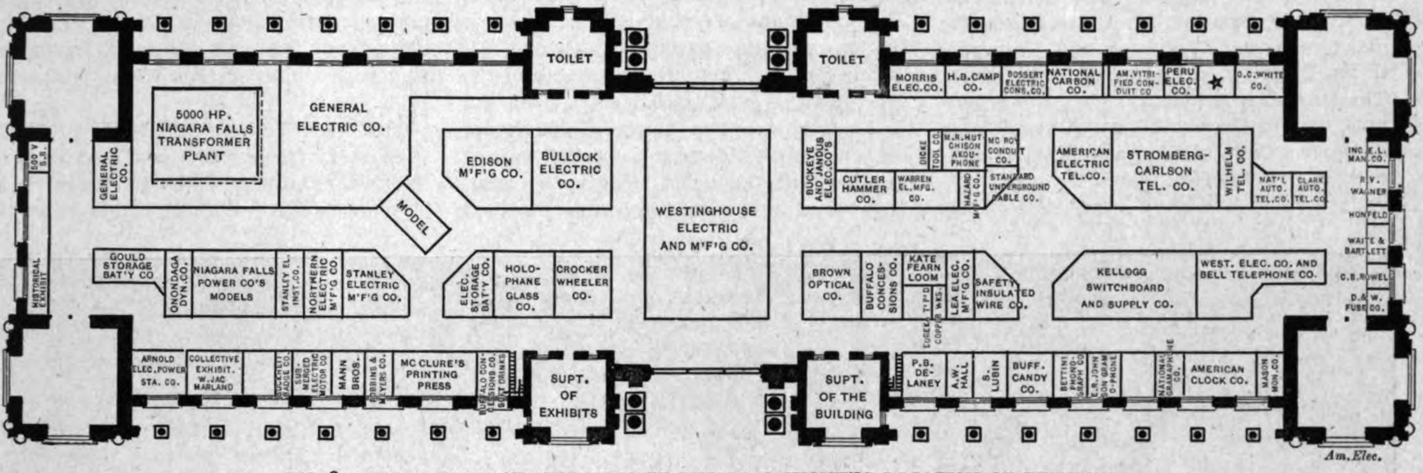


FIG. 3.—FLOOR PLAN OF ELECTRICITY BUILDING SHOWING LOCATION OF EXHIBITS.

THE HAZARD MANUFACTURING COMPANY, of Wilkesbarre, Pa., has a handsomely arranged space with a railing of Hazard wire rope around it. At the back of the booth are shown the ropes and cables for haulage and mechanical purposes. This, however, includes a very large copper cable which has a hemp core to give flexibility in handling. In the case in front are samples of electrical submarine and underground cables. The balance of the space is taken up with magnet, weatherproof and rubber-covered wires.

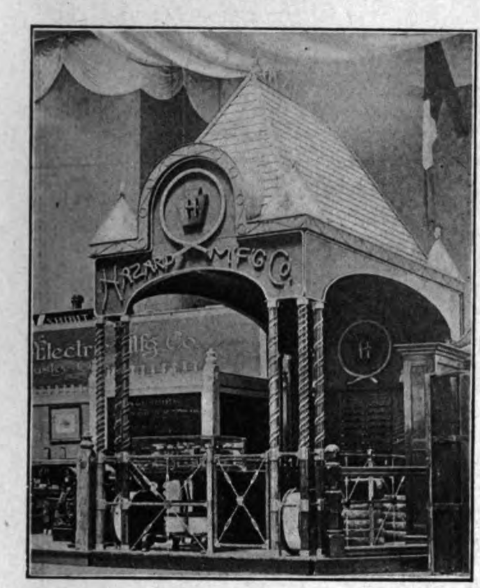


FIG. 4.—HAZARD WIRES AND CABLES.

THE EDISON MANUFACTURING COMPANY, of Orange, N. J., has a large display of phonographs, including some historical apparatus. Edison-Lalande batteries, fan motors and the kinetoscope are also included. It is expected later to have the new thermopile and the new Edison storage battery on exhibition, both of which will doubtless attract much attention. W. H. Markgraff is manager of the exhibit.

THE McROY CLAY WORKS, Brazil, Ind., shows a sample of four-duct conduit laid between two manhole walls and also samples of two and four-duct conduit. McRoy conduit made in 6-ft. lengths is too well known to need introduction or explanation.

THE CLARK AUTOMATIC TELEPHONE SWITCHBOARD COMPANY, of Providence, R. I., has several automatic switchboards in this space, one of which is wired up to instruments around the booth to show the operation of the system. This system is applicable to exchanges of 150 lines and is especially valuable to take the place of intercommunicating systems which have become overloaded. But one movement is required in securing connection by this system. A 24-point board is used for illustrating the working of the system. L. A. Stillings and F. Ingraham are looking after the exhibit.

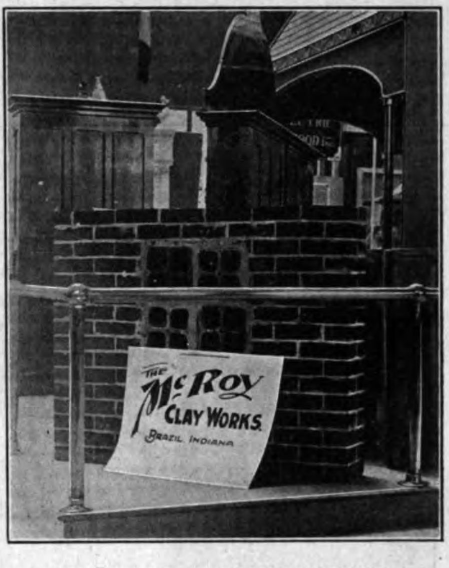


FIG. 7.—A WELL-KNOWN CONDUIT.

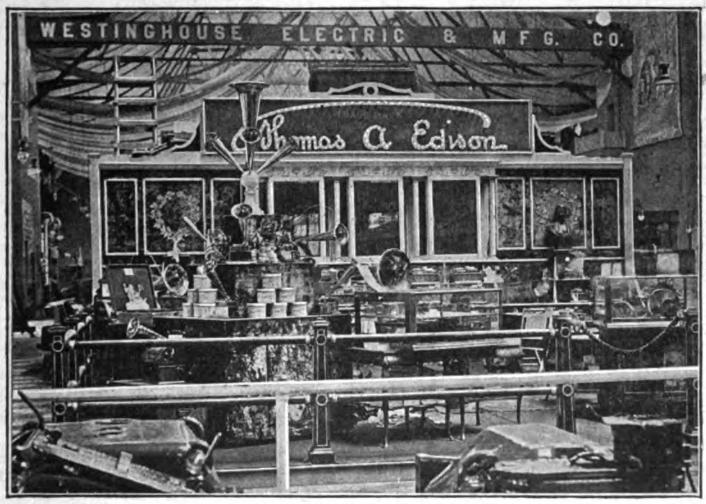


FIG. 5.—EDISON APPARATUS.

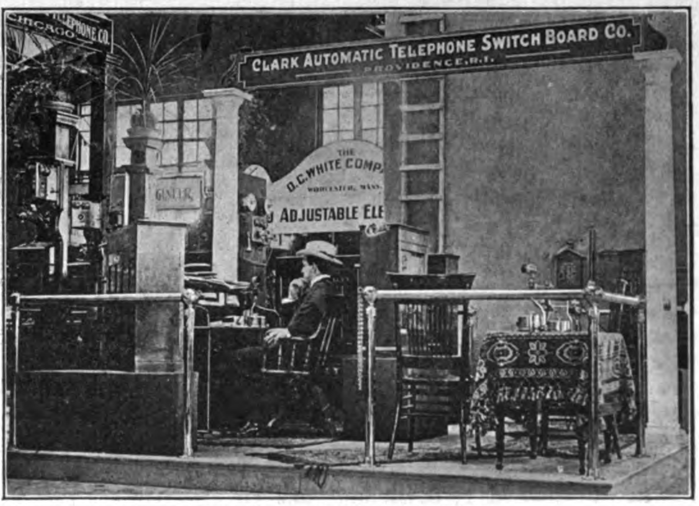


FIG. 6.—CLARK TELEPHONES.

THE BUCKEYE ELECTRIC COMPANY and JANDUS ELECTRIC COMPANY, both of Cleveland, Ohio, have a combination exhibit at the Exposition in charge of Warren E. Musser and Bailey Whipple. The regular lines of Jandus and Buckeye products are shown. In addition to the booth exhibit in Electricity Building, Jandus arc lamps are shown in service in the Horticulture, Mines and Forestry Buildings, which are illuminated by these lamps.

THE JOHN A. ROEBLING'S SONS COMPANY, Trenton, N. J., has handsome quarters in the Machinery and Transportation Building, in charge of G. W. Swan. The Brooklyn Bridge model is the prominent part of the exhibit as viewed from a distance. Coils of the various wire products of the Roebling factories are tastefully arranged in show cases and on the floor. The tired visitor can rest in rocking chairs of unique design made to resemble wire reels as much as possible.

THE CLING-SURFACE MANUFACTURING COMPANY, of Buffalo, has an operative exhibit in the Machinery and Transportation Building which demonstrates very clearly and in a scientific manner the holding power of the "Cling-Surface" preparation for belts. Two 2¾-kw. Westinghouse dynamos are driven by a 10-h. p. motor, through pulleys and belts of the same size. Each dynamo is mounted on a dynamometer frame which indicates continuously the tension on the belts. The conditions are exactly the same for the two machines except that on one belt "Cling-Surface" has been applied and the other belt is untreated. As a load for these machines two banks of 100 lamps each are provided, placed on the wall at the back of the booth. With the same number of lamps and the same total belt tension on both dynamos, the lights on the dynamo driven by the "Cling-Surface" belt are always much the brighter if anywhere near full load is on. Cross-connection switches are provided so that the dynamos can be connected to either bank of lamps, and it can be demonstrated that the circuit conditions of both are identical. The greater slip of the untreated belt is evident not only from the dimness of the lamps and low voltmeter reading, but from the sag in the treated belt under load. This demonstration is going on continuously during the hours the building is open. J. L. Harper is engineer in charge. Wm. Dickson Young, secretary of the company, and Albert D. Young, also devote some of their time to the exhibit.

THE AMERICAN STEEL & WIRE COMPANY has a very large and comprehensive exhibit in the Machinery and Transportation Building, which shows the great variety of products turned out by its many departments. In one part is shown the evolution from iron ore, coal and coke, to finished wire. Sub-marine lead-covered and rubber-covered wires and cables, figure-8 trolley wire, round and square magnet wire, lamp cord, and all the solid and stranded types of "Crown" rail bonds form the electrical part of the display. The exhibit is so complete in all departments that one can give it consider-

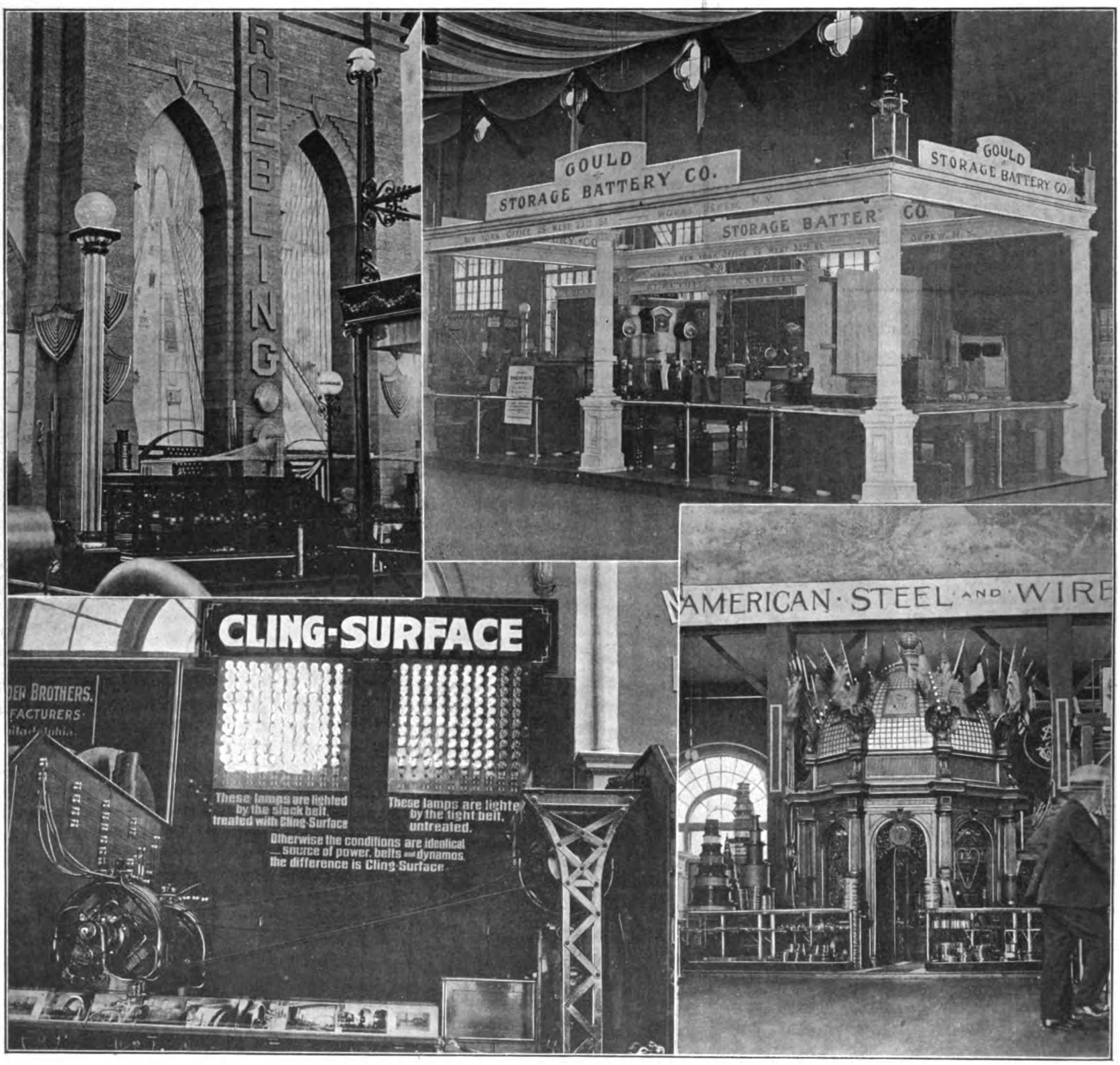

ROEBLING
GOULD STORAGE BATTERY CO.
STORAGE BATTERY CO
GOULD STORAGE BATTERY CO.
CLING-SURFACE
These lamps are lighted by the slack belt, treated with Cling-Surface
These lamps are lighted by the tight belt, untreated.
Otherwise the conditions are identical — source of power, belts and dynamos the difference is Cling-Surface
AMERICAN·STEEL AND WIRE

FIG. 8.—A GROUP OF INTERESTING AND ATTRACTIVE EXHIBITS.

able study without being tired by repetition. Norton H. Van Sicklen is in charge.

THE GOULD STORAGE BATTERY COMPANY, of Depew and New York, N. Y., exhibits the largest storage battery cell in the world. This is of 16,000 ampere-hours capacity at the 2000-ampere or 8-hour rate; 14,000 ampere-hours capacity at the 5-hour rate; 12,000 ampere-hours capacity at the 3-hour rate, and 8000 ampere-hours at the 1-hour rate. The total weight of the cell is 8750 lbs., divided as follows: Elements, 5752 lbs.; tank, 1100 lbs.; acid, 1898 lbs. To charge this cell a low-voltage dynamo is employed, driven by a 10-h.p. Bullock motor. There are 52 negative plates and 51 positives. Besides this cell there is a very complete set of samples of plates showing them both before and after forming, and the way they are "spun" to get seventeen times the original plane surface. Cells partially assembled and unassembled show all the details of construction and insulation. Walter Gummey and T. S. Witherbee are in charge.

THE PERU ELECTRIC MANUFACTURING COMPANY, of Peru, Ind., has a very tastily arranged booth. The sides and back are formed of boards on which are mounted a complete array of samples of the extensive line of porcelain goods made by this company for electrical purposes, including rosettes, plugs, sockets, receptacles, cut-outs, insulators and a line of knife switches which have porcelain handles and cross-pieces so that the entire switch has nothing but copper and porcelain in its make-up. The rear wall contains various forms of fuse-blocks, and samples of the company's 30,000-volt porcelain insulators. F. J. Setelle is in charge.

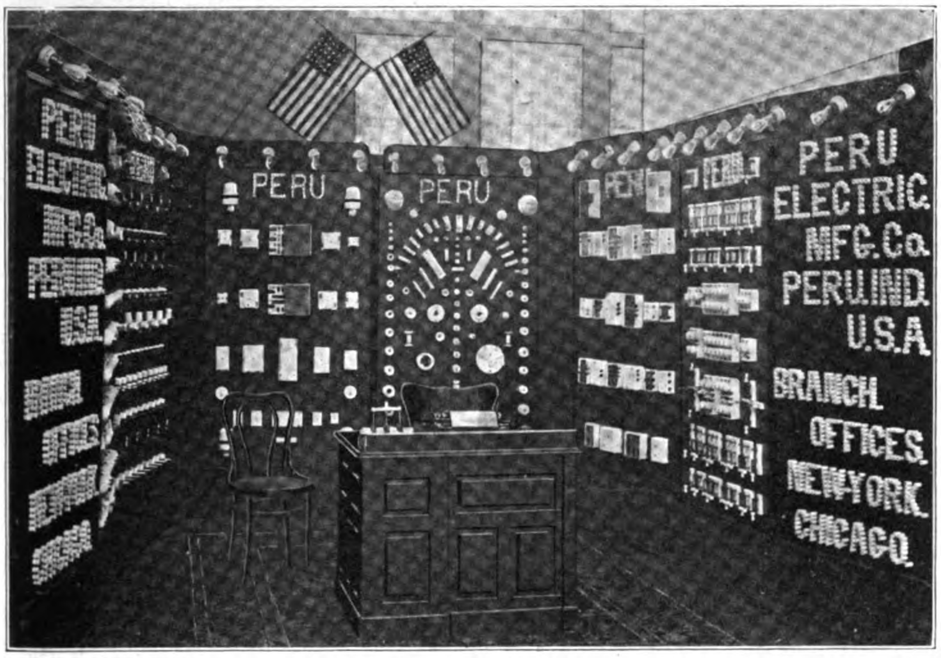

PERU
PERU
PERU ELECTRIC MFG. Co. PERU. IND. U.S.A
BRANCH OFFICES NEW-YORK CHICAGO

FIG. 9. PERU ELECTRIC MANUFACTURING COMPANY'S EXHIBIT.

THE HARRISON SAFETY BOILER WORKS, of Philadelphia, has an effective working exhibit. All of the steam from the boilers in the Service Power Plant in the area of the Machinery and Transportation Building passes through an 18-in. Cochrane horizontal receiver separator, and thence to the several power units of which there are in all eleven engines, two boiler feed pumps and one condenser pump of an aggregate nominal rating of 2200 horse-power. Nine of the engines and the pumps run condensing while two of the engines run non-condensing to furnish exhaust steam for heating the feed water in the Cochrane heater. The exhaust from the engines which are run condensing passes through Cochrane horizontal vacuum oil separators; one 12-in. and two 16-in. separators are used for this service. These separators are drained into a tank of suitable size to hold the drainage accumulating from the separators during five or six hours. Connections are made from the separators to the tank and from the tank to the exhaust pipe beyond the separators; this arrangement provides for maintaining a vacuum in the tank equal to the vacuum in the well of the separator thus insuring effective drainage. When the tank is nearly filled, a float, operating through a suitable mechanism, causes a steam whistle to blow, which warns the attendant. The tank is emptied by closing the valves in the pipe communicating with the separators and opening a valve to the blow off or waste connection.

The exhaust steam after being relieved of oil by the Cochrane separator passes to a surface condenser and the condensation therefrom is delivered to a 2000-h.p. Cochrane feed water heater and purifier. The fresh water necessary to supplement this supply is introduced into the heater through a balanced regulating valve which is automatically controlled by means of a float in the heater.

THE INCANDESCENT LIGHT MANIPULATOR COMPANY has the contract for furnishing appliances for renewing and cleaning the thousands of incandescent lamps used around the Exposition buildings. This company's devices, which are exhibited in an attractive booth in the northeast corner of Electricity Building, are made for the purpose of cleaning or renewing incandescent lamps in any position, however difficult. They are made of aluminum for lightness and are a great boon to the Exposition as well as to all others who use them.

PERSONALS.

MR. A. J. MACDONALD, recently in charge of the central division of the Montreal Street Railway system, has been appointed general superintendent of the street railway system of the city of Mexico.

MR. I. McC. BEAN, formerly associated with the Dickson Manufacturing Company, has been appointed editor of "Science and Industry," published by the Colliery Engineering Company, Scranton, Pa., to succeed Mr. W. Gratz, whose resignation is noted below.

MR. C. L. EDGAR, president and general manager of the Boston Edison Electric Illuminating Company, having consummated the consolidation of his company with the Boston Electric Light Company, has gone to Europe for a much-needed rest of two months.

MR. R. T. SCOTT, of Oxford, Ill., who was for several years superintendent of the Knoxville Light & Power Company, Knoxville, Tenn., resigned that position recently to accept the appointment as assistant to Manager Shepard at the Cleveland office of the General Electric Company.

MR. GEO. E. WELLS, formerly connected with the Wagner Electric Manufacturing Company, St. Louis, has formed a co-partnership with Mr. E. Reubel, under the firm style of Reubel & Wells. The new firm will do consulting engineering, and its headquarters will be at 1112 Chemical Building, St. Louis.

MR. W. GRATZ, who has been for some time past connected with the International Correspondence Schools at Scranton, Pa., and editor of "Science and Industry," has resigned his position there to join the staff of Elmer G. Willyoung, New York, the well-known manufacturer of electrical measuring instruments.

PROF. W. M. RIGGS has been advanced to the head of the mechanical department of Clemson College, Clemson, S. C., with the title of Professor of Electrical Engineering and Director of the Mechanical Department. Prof. Riggs' election to this post was unanimous and made without any solicitation or request on his part.

MR. RALPH J. PATTERSON, who for three years past has been chief engineer and electrician of the Woburn Light, Heat & Power Company, Woburn, Mass., has resigned his position to accept that of treasurer and manager of the Waterville & Fairfield Railway & Lighting Company, of Waterville, Me. Mr. Patterson's associates and subordinates in the employ of the Woburn Company presented a gold watch and chain and Masonic charm to him upon his severing his relations with the company as a mark of the high esteem in which he is held.

MR. V. H. WAGGONER, formerly of Grand Rapids, Mich., who has for 10 years past been connected with various electrical plants in this country and Canada, has gone to Cape Town, S. Africa, where he is in charge of the electrical department of the Cape Town Tramway Company. Mr. Waggoner is enthusiastic on the subject of American electrical machinery, and expresses the opinion that there is an excellent field for it in South Africa. He will be glad to hear from any American manufacturers who wish apparatus and machinery installed in his section, or who are desirous of establishing a footing in South Africa. The keen competition of American manufacturers has created a considerable anti-American feeling among Englishmen, so that unless American firms are represented personally in South Africa they will probably find it difficult to secure contracts.

MR. P. WERNER, who was for several years with the E. P. Allis Company, has accepted the position of chief engineer and general superintendent with the Filer & Stowell Company, Milwaukee, Wis. Mr. Werner is a native of Sweden, where he received a thorough education in mechanical engineering. He is a graduate of the Stockholm Institute of Technology, and has also had the benefit of actual shop practice in both the foundry and machine departments. Mr. Werner has held several important positions in this country as draughtsman and designer. At the Allis works he succeeded through the excellence of his work in gaining the full confidence and friendship of Mr. Edwin Reynolds, the chief engineer of the company. This was amply demonstrated by the fact that Mr. Reynolds trusted to Mr. Werner the design and construction of such important engines as those recently built for the Metropolitan and Manhattan Railway companies of New York.

TRADE PUBLICATIONS.

CABLE TESTING APPARATUS. Jas. G. Biddle, Philadelphia.—This is catalogue No. 360, in which are described the Fisher cable testing instruments manufactured by Morris E. Leeds & Co., for whom Mr. Biddle is the sole sales agent.

TELEPHONE INSTRUMENTS AND SUPPLIES. Farr Telephone & Construction Supply Company, Chicago.—This is a circular of the poster variety, containing illustrations of the standard Farr telephone instruments, parts and accessories.

SCALES. C. W. Hunt Company, New York.—A pamphlet catalogue of an extensive line of industrial scales. The line includes platform railway scales, automatic and cable railway scales, suspension scales for boiler rooms, weighing hoppers, etc.

MACHINE SHOP FURNITURE. The New Britain Machine Company, New Britain, Conn.—A pocket-size pamphlet, in which are illustrated and described tool trays which are made up either singly or in racks mounted on casters to facilitate moving the racks about; the racks are made up with two, three and four trays.

TELEPHONE APPARATUS AND SUPPLIES. Commercial Electrical Supply Company, St. Louis, Mo.—A pamphlet catalogue containing illustrations, descriptions and prices of telephone instruments and accessories of all kinds, including switchboards, desk sets, generators alone, testing magnetos, induction coils, etc., etc.

SELF-OILING ENGINES. The Ball Engine Company, Erie, Pa.—This is a well-executed little booklet of vest-pocket size, which was prepared by the Ball Engine Company primarily for distribution at the Pan-American Exposition. The pamphlet contains small but finely-executed illustrations of the company's various styles of horizontal automatic self-oiling engines and of the principal parts of the engines.

ABOUT METERS. Stanley Instrument Company, New York and Great Barrington, Mass.—This is an extremely useful book of standard catalogue size and executed in pamphlet form, containing a discussion of wattmeter construction and testing. While the book is intended primarily to advance the interests of the publishers, it gives a great deal of useful and accurate information concerning wattmeters generally.

THINKABLE THINKLETS. Warren Electric Manufacturing Company, Sandusky, Ohio.—This is a well-executed folder of pocket size enclosed in a substantial paper cover, bearing the title here given. The folder is of the accordion-plait variety and contains illustrations of the complete Warren line of alternators and transformers, together with some cogent arguments as to the advisability of the use of this apparatus.

GRAPHITE PRODUCTIONS. Joseph Dixon Crucible Company, Jersey City, N. J.—The latest catalogue of this well-known company, in which are described all of its graphite products. The line includes familiar brazing crucibles, graphite facings, lubricating graphite for engine cylinders and another grade for bearings, brushes for dynamos and motors, and last, but by no means least, the fine line of Dixon graphite pencils.

STEAM SPECIALTIES. Jas. L. Robertson & Sons, New York.—This is the latest edition of this firm's catalogue, containing illustrations and descriptions of the well-known and widely-used steam specialties which it manufactures and deals in. Prominent among these are Hine eliminators, Robertson feed-water heaters, Merrill automatic grease cups, Robertson-Thompson indicators, Willis planimeters, and Barrus calorimeters.

NET PRICE LIST AND DISCOUNT SHEETS. Western Electrical Supply Company, St. Louis, Mo.—This is a pocket book containing complete price lists and discounts applying to the Western Electrical Supply Company's general catalogue No. 22. The book is bound in heavy linen, contains about 125 pages, and is of convenient size and arrangement. It is a highly satisfactory publication for jobbers and electrical contractors, as it contains current prices of almost every piece of apparatus used in electrical work.

DIRECT-CURRENT MOTORS. Akron Electrical Manufacturing Company, Akron, Ohio. —This is Bulletin No. 84, in which are described and illustrated direct-current multipolar motors for belt driving. These motors are of the modern circular-yoke type, having four radial poles up to the 50-h.p. size and six poles above that size. The machines are wound for the standard direct-current voltages, and are built with laminated magnet poles cast into cast-iron yoke rings and equipped with pole-shoes for providing a commutating fringe.

ELECTRICAL SUPPLIES. Manhattan Electrical Supply Company, New York and Chicago.—This is the Manhattan Company's twelfth catalogue of electric light, power, railway, telephone, telegraph, and household supplies and fittings. The company has wisely restricted the superficial size of the catalogue to standard dimensions, notwithstanding that this necessitated the use of nearly 500 pages. The catalogue is very well executed, the illustrations being rather better than are usually found in trade publications of so general a character.

LIGHTNING ARRESTERS. General Electric Company.—This is publication No. 1034, devoted to lightning arresters, and containing a very appropriate preliminary article on the subject of "Thunderstorms," written by Alfred F. Sims, the local Weather Bureau official at Albany, N. Y. Following Mr. Sims' interesting article are descriptions of G. E. lightning arresters for direct-current constant-potential and series circuits, alternating-current primary and secondary circuits, constant-current transformers, etc. The book contains also a series of diagrams of lightning arrester connections, which should prove useful to central station men.

INDEPENDENCE DAY SOUVENIR. American Electrical Works, Providence, R. I.—This company, which has established a national reputation for its clever Fourth of July mementos, issued this year a folder containing a fine picture of Independence Hall, Philadelphia, and etchings of the old Liberty Bell, the table on which the Declaration of Independence was signed, and the chair occupied by John Hancock as president of the 1776 Congress. The pamphlet also contains two pages of information relating to the pictures mentioned. This souvenir is the most attractive that the company has thus far issued within the writer's recollection.

STORAGE BATTERIES. Gould Storage Battery Company, Depew and New York, N. Y.—This is a handsomely-executed catalogue of standard size, illustrating and describing all types of the Gould storage battery. One of the strong features of this battery, as most of our readers doubtless know, is the construction of the plate, the surface of which is divided up into an enormous number of alternate ribs and grooves by a process known as "spinning." The object of this process is to increase the contact area between the active material and the lead con-

A COMMUTATOR NECESSITY.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.

50c. per Stick. $5.00 per Dozen.

For Sale by all Supply Houses.

Upon receipt of this coupon we will send FREE, sample stick.

Name...
Address..
A. E.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO.

ducting plate, and the result is an increase in the actual area to a value seventeen times that of the original superficial area of the plate. The catalogue contains complete data. including dimensions, weights, etc., relating to the batteries.

MARINE STEAM. The Babcock & Wilcox Company, New York.—This is a companion book to the Babcock & Wilcox Company's book entitled "Steam," which is well known and highly prized by all users of boilers. The present production is of uniform size with the first book, and relates, as its title indicates, to steam production on board ship. It opens with a brief history of the water-tube boiler, which is of much interest; this is followed by a chapter on the requirements of a marine water-tube boiler, and a description of the Babcock & Wilcox type. The book is profusely illustrated and beautifully executed. It contains, among other features of value, a table giving the calorific quality of various domestic and foreign coals, an efficiency diagram from which can be determined the efficiency of any boiler performance, and a chapter on the use of the steam calorimeter. There are also contained records of tests made on Babcock & Wilcox boilers on board various steamships.

BUSINESS NEWS.

THE MOLONEY ELECTRIC COMPANY, St. Louis, Mo., has just appointed H. B. Coho New York representative for the sale of the well-known Moloney transformers in the East.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is marketing a new dry battery known as the "Eaco," which is especially recommended for telephone work and wherever heavy open-circuit work is required.

JAS. McCREA & CO., Chicago, have appointed the Kilbourne & Clarke Company, Seattle, Wash., sales agents for the Roberts boring machine in that part of the country. The Seattle house will carry a stock of boring machines on hand, so that shipments can be made promptly.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa., desires to announce that the schools do not close during the summer months. This is a most convenient arrangement for students of the courses of these schools, as it obviates a long break in their studies, which is always more or less disadvantageous.

STATE LINE MANUFACTURING COMPANY, Chattanooga, Tenn., maker of lava insulators, gas-jet tips, etc., has established an Eastern and export office at 107 Chambers Street and 91 Reade Street, New York, where a full stock of the company's products will be carried, in order that prompt shipment to Eastern points may be made from this office.

THE CENTRAL ELECTRIC COMPANY of Chicago has placed on the market a new dry battery, known as the "Ideal." This battery is claimed to have low specific internal resistance, high voltage and current output, and to be remarkably recuperative. It is said to embody all of the desirable features which should be found in a high-grade cell.

THE AMERICAN INSULATING MACHINE COMPANY has been formed for the manufacture and sale of insulating machinery and supplies, with offices at New Haven, Conn., and 940 North Third Street, Philadelphia. Thomas S. Reed, formerly of the American Electric Works at Providence, R. I., and Robert W. Withington, of Philadelphia, are interested in the new company.

THE PHELPS COMPANY, Detroit, Mich., manufacturer of the well-known Hylo lamp, has enhanced its popularity by sending out souvenir lamps intended as mementos of the recent Electric Light Convention. The lamp is accompanied by some excellent advice concerning the use of incandescent lamps and generally very explicit instructions relating to the use of the Hylo lamp in particular.

THE LAMP TESTING BUREAU, Harrison, N. J., has removed its office and laboratory to No. 14 Jay Street, New York City. The testing laboratory at Harrison will be continued and the work done there will be the selection and testing of Edison lamps. The business office of the company will be at the New York address, and the laboratory there will do all the checking, calibration and fine technical work.

COMMERCIAL ELECTRIC COMPANY, Indianapolis, Ind., advises us that a branch office has been established at 409 Crozier Building, Philadelphia, in charge of L. Lewis, who will look out for the company's interests in Philadelphia and the surrounding territory. The company has made arrangements with the McCay Engineering Company, of Baltimore, Md., for the sale of Commercial apparatus in that city and vicinity.

GARTON-DANIELS COMPANY, Keokuk, Iowa, reports that the present demand for Garton lightning arresters is the largest that has ever been noted in the history of the company. The company's foreign business is on the increase, as well as its domestic trade, indicating what has been repeatedly demonstrated in other lines, that the excellence of American apparatus is appreciated in other countries as well as at home.

MONTAUK FIRE DETECTING WIRE COMPANY is the new name of the corporation which has previously been known as

The Telephone Service is The Quickest Messenger.

Rates in Manhattan from $5 A MONTH. One Year Contracts. Monthly Payments.

NEW YORK TELEPHONE CO.
15 Dey Street. 111 West 38th Street.

CREAM FLUX

An Absolutely Non-Corrosive Insulating Soldering Flux FOR ALL METALS.

So EASILY APPLIED that all CAN USE IT.
So CHEAP that all SHOULD USE IT.
So EFFICIENT that all MUST USE IT.

PUT UP IN CANS AT
15c., 25c., 45c. and 75c.
SPECIAL PRICES IN QUANTITY.
SEND FOR TRIAL BOX.

Endorsed by the National Board of Fire Underwriters and all users.
We guarantee it, and if not satisfactory, money will be refunded.
FOR SALE BY ALL SUPPLY HOUSES OR

CREAM FLUX CO., SOLE MANUFACTURERS, 100 Washington St., CHICAGO

BIG STICK, 35 CENTS.
Sample Free.
SOUTHWORTH & HARE,
Indianapolis, Ind.

ERICSSON

Means best. Satisfaction guaranteed. No buzzing. Talks clear and distinct. Of neat appearance.

CATALOGUE FREE ON APPLICATION.

Ericsson Telephone Co., 296 Broadway, N. Y. City.

Our No. 219.

For the latest reading on Electrical Tools, read the GREEN BOOK of Hardware Specialties.

SMITH & HEMENWAY CO.
UTICA DROP FORGE & TOOL CO., 296 Broadway, N. Y.

PLATINUM

PLATINUM FOR CONTACT POINTS IN ELECTRICAL INSTRUMENTS.
PLATINUM FOR TELEPHONES. PLATINUM FOR ELECTRICAL INSTRUMENTS.

We sell PLATINUM in any quantity, either large or small. We buy PLATINUM, or anything containing PLATINUM, in any quantity.

FOR INCANDESCENT LAMPS AND EVERYTHING ELSE.

BAKER & CO.

MANUFACTURERS OF PLATINUM IN ALL SHAPES.

Newark, N. J. New York Office, 120 Liberty St.

the Montauk Multiphase Cable Company, with offices at 100 Broadway, New York. The change in name is not due to any change whatever in the organization or management, but was made solely for the purpose of more explicitly conveying to the public an idea of the character of the company's product.

THE STILWELL-BIERCE & SMITH-VAILE COMPANY, Dayton, Ohio, recently shipped to the North Carolina Electrical Power Company at Marshall, N. C., a special 27-in. improved cylinder gate Victor turbine of bronze, mounted on a horizontal shaft in a wrought-iron flume. The wheel is to work under a 60-ft. head and develop 750 horsepower. It will be used for driving a generator supplying current to one of the street railways of Asheville, N. C.

THE BELKNAP MOTOR COMPANY, Portland, Me., is enjoying a rushing export business in generators, motors and potential regulators. The company is bringing out a new type of generator and motor, which will be built in sizes up to 500 horse-power in motors and 8000 lights in generators. The well-known voltage regulator built by this company has been improved recently, and the manufacturers think now that there is nothing more to be desired in its construction and operation.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, recently organized at Warren, Ohio, has been incorporated with $50,000 capital stock by W. H. Smith, F. B. Wadsworth, C. G. Dennison, G. C. Webster and F. A. Milliken. The company will engage in the manufacture of incandescent lamps, meters, etc. It has received from the Boards of Trade at Lorain and Niles, Ohio, and Jamestown, N. Y., propositions relative to a location for its plant, but has not yet decided upon a site.

THE WESTERN ELECTRIC COMPANY, Chicago, has had an exceedingly active trade in electric fans. On one day it received a telegraphic order for three thousand fan motors to be shipped to New York by fast express. The order was received late in the afternoon, and by one o'clock the next morning the four special cars engaged to carry the stock were loaded. The United States Express Company used thirty of its largest wagons to carry them from the Western Electric Company's plant to the depot.

A. L. IDE & SONS, Springfield, Ill., have just completed a new addition to their already extensive works, comprising a new foundry and drafting rooms, located in a two-story brick building 160 feet square, containing two cupolas of a capacity of 14 tons each. The old foundry is to be changed into a machine shop and the old machine shop changed into testing rooms. A new office building is being constructed on the lot adjoining the present office. The capacity of the works will be increased 50 per cent by the additions.

THE THRESHER ELECTRIC COMPANY, Dayton, Ohio, reports among other recent contracts the following from the United States Government: Two 200-kw. direct-connected machines for the Brooklyn Navy Yard; two 75-kw. for the National Soldiers' Home, Dayton, O.; three 50-kw. for the New Orleans Post Office; one 50-kw. for the Kansas City Post Office; one 80-kw. for Fort Hamilton, and one 37½-kw. and one 62½-kw. for Fort Wadsworth. Also five 15-h.p. special line shaft motors, 150 r.p.m., for the Mare Island Navy Yard.

CUTLER-HAMMER RHEOSTATS AT THE EXPOSITION.—The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., advises us that a careful examination of all the motor exhibits at the Pan-American Exposition has disclosed the fact that Cutler-Hammer rheostats are in use in connection with more than three-fourths of these motor exhibits. The company considers that this is logical evidence that the majority of motor builders use Cutler-Hammer motor starters, and is naturally very much gratified at the showing.

THE AMERICAN ELECTRIC FUSE COMPANY, Chicago, has purchased the business of the Rolfe Electric Company, together with all manufacturing and selling rights for Rolfe circuit protectors. The American Electric Fuse Company will continue the manufacture of these protectors in all the standard designs, and are introducing several new styles designed particularly for the protection of the lines of small telephone exchanges. The Rolfe protectors have been approved by the National Board of Fire Underwriters.

GEO. W. LORD, of Philadelphia, manufacturer of Lord's boiler compounds, reports that his European business has grown to such an extent that it has been decided to establish a number of additional branches at several points in Europe. These branches will be in charge of American managers and salesmen, and will be equipped with the latest improved American office appliances. As heretofore, all goods will be manufactured in Philadelphia, but a stock of chemicals, prepared specially for the waters used in the steam boilers of the various districts, will be carried by each branch.

D. M. STEWARD, Chattanooga, Tenn., who is the owner of all the patents under which the D. M. Steward Manufacturing Company has been operating for years past, has purchased the entire plant and business of the company. There have been for some time serious differences between the Stewards and some of the other stockholders of the D. M. Steward Manufacturing Company, in order to eliminate which Mr. Steward made several very liberal offers for the holdings of the other stockholders. These offers being refused, and it being impractical to operate in harmony, the company was placed in the hands of a receiver for the purpose of winding up its affairs, and sold at auction by the receiver, with the result mentioned above. These occurrences have not interfered in the slightest with the filling of orders or other transaction of business by the Steward factory, nor will the purchase of the plant by the Steward interests produce any change in business policy or management. There will also be no change in name.

THE LAGONDA MANUFACTURING COMPANY, Springfield, Ohio, is much gratified by a letter from the American Steel & Wire Company endorsing an equipment of Weinland water power and mechanical tube cleaners which the Lagonda Company recently installed in the Cleveland plant of the American Company. The Lagonda Company has also received the following flattering letter concerning its Weinland tube cleaners:

"Your Mr. Maloy has just finished cleaning a water tube boiler with one of the Weinland Tube Cleaners. The first agreement was to clean this for a stated price. We, however, liked the machine so much that we have purchased same, and cheerfuly recommend the use of this machine to any one operating water tube boilers. It is by far the best machine for this purpose we have ever tried.

"Yours very truly,
"THE LEXINGTON RAILWAY CO.,
"Lexington, Ky. H. T. Gunn, Supt."

THE NEW PROCESS RAW HIDE COMPANY, Syracuse, N. Y., some time ago received the following flattering letter:

"The experience we had with your rawhide pinions last year at the Paris Exposition we presume will be of great interest to you as their performance was a very remarkable one. These pinions were used on an electric motor which operated one of our four-deck straight-line newspaper perfecting presses, on which we printed the daily Paris edition of the New York 'Times.' We were going along smoothly one afternoon, when all at once the whole press seemed to take a jump upwards, and we thought the whole machine was broken and disabled. The power was shut off at once, and upon examination we found the teeth of one of the cast-iron gear wheels had broken out; these teeth were imbedded in the rawhide pinions. The pinions themselves were not injured except for the iron teeth pounded into them. These we picked out and we ran the same pinions and finished not only that day's edition but they were used until the end of the Exposition and were not worn out then.

"We afterward found the cause of the sudden change in speed to be due to a change at the power station.

"We are pleased to write this very strong endorsement of your New Process pinions for we feel that you deserve it.

"Very truly yours,
"THE GOSS PRINTING PRESS CO."
"Chicago, Ills."

PRATT INSTITUTE
BROOKLYN, N. Y.
TWO YEAR COURSES IN
Applied Electricity
AND IN
Steam and Machine Design
Write for Catalogue and Particulars.

SOLID TRAINS TO NORTHERN MICHIGAN.

The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

THE MASON
Reducing Valves
ARE THE WORLD'S STANDARD VALVES

For automatically reducing and absolutely maintaining an even steam or air pressure.

They are adapted for every need and guaranteed to work perfectly in every instance.

Write for full information and splendid references.

THE MASON REGULATOR CO. Boston, Mass., U. S. A.

American Electrician.

Vol. XIII. New York, September, 1901. No. 9

A MODERN SOUTHERN CENTRAL STATION.

THE NEW POWER HOUSE EQUIPMENT OF THE CONSOLIDATED ELECTRIC LIGHT & POWER COMPANY, BIRMINGHAM, ALA.

BY J. R. WILLIAMS.

That Birmingham, Ala., has kept pace in central station development with many of the more pretentious cities of the country will be evident upon an inspection of the plant of the Consolidated Electric Light & Power Company and of the company's plans for future extensions. There still remain in the station a few of the older-style generators, but these will give way in the immediate future to machines of the latest types. With the exception of a few isolated plants, the company supplies all lighting service in Birmingham, Pratt City, Ensley, Avondale and Woodlawn, and also supplies current to about 90 miles of street railway owned and operated by the Birmingham Railway & Electric Company.

The steam equipment of the station comprises 24 horizontal return-tubular boilers, 14 of which were built by the Birmingham Boiler Works; four simple non-condensing Corliss engines, built by the Lane & Bodley Company, of Cincinnati, Ohio; six simple non-condensing Corliss engines, built by the Birmingham Machine & Foundry Company, and one single-valve automatic engine, built by the Harrisburg Foundry & Machine Works, Harrisburg, Pa. The exclusive use of simple non-condensing engines is due to the fact that fuel is so cheap that the saving which could be effected by the use of compound condensing engines would not cover the interest and maintenance on the additional equipment required for so operating the plant.

The Lane & Bodley engines drive shafting from which belted generators are driven. The engines are 21 ins. x 48 ins., 18 ins. x 42 ins. and 26 ins. x 48 ins. All of them have girder-type frames; two are equipped with wrist-plate gear and the other two with the latest form of direct-acting gear. The six engines of local manufacture are shaft-connected in pairs. Two of these pairs have cylinders 24 ins. x 48 ins. and are direct-connected to two General Electric 875-kw. railway generators, which they drive at 82 r.p.m., each

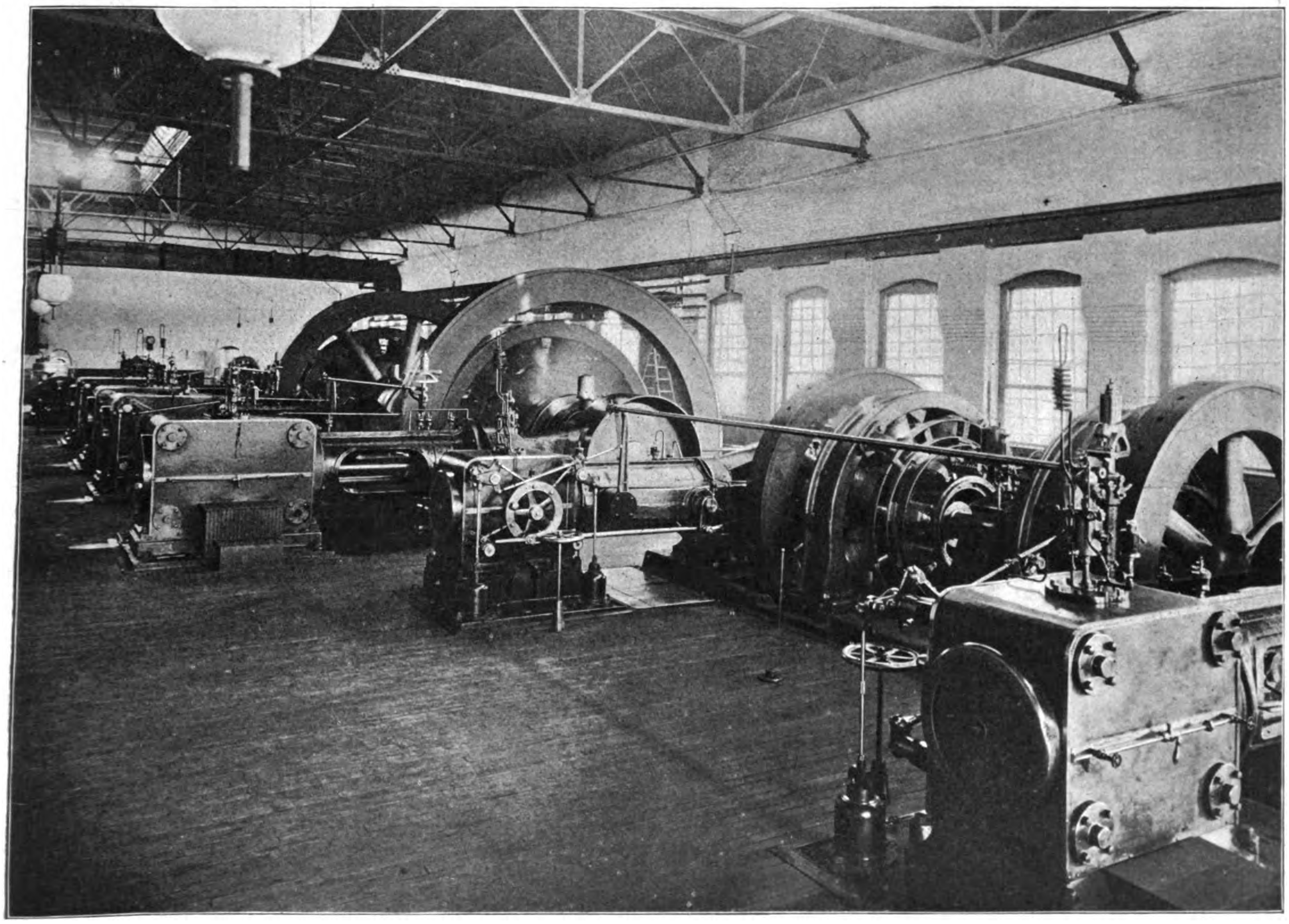


FIG. 1.—ENGINE AND GENERATOR ROOM OF THE CONSOLIDATED ELECTRIC LIGHT AND POWER COMPANY.

pair of engines driving one generator. The third pair of engines are shaft-connected to each other and to two 200-kw. 125-volt General Electric lighting dynamos, the whole group constituting a single generating equipment. These engines have cylinders 20 ins. x 30 ins. and run at 150 r.p.m. This speed, it will be noticed, is above the usual rate of even the higher-speed Corliss engines of modern design, but six months' service has not developed any trouble from the high rate of valve operation. All six of the Birmingham engines have double wrist-plates, one to drive the exhaust valves and the other to open the admission valves; Fig. 1, on the first page, is a view of this engine group and Fig. 7 is a partial view of the high-speed set. The Harrisburg engine is a 20 x 20, and is direct-connected to two 100-kw. 125-volt lighting dynamos, which it drives at 200 r.p.m.

All of the engines take steam at 120 lbs. pressure (gauge) from a single 14-in. riveted wrought-iron header which is located in the basement of the new part of the building and is directly back of and above the boilers in the old part of the plant. The general arrangement of the steam piping in the new part is shown by Figs. 2 and 3; the former being a plan and the latter a sectional view. As shown in the drawing, the steam main is supported from the roof trusses. All of the steam piping is of extra heavy wrought iron. The valves are Chapman, and all joints are packed with Rainbow packing (Peerless Rubber Manufacturing Company, New York). The exhaust piping is extra heavy cast iron, with the exception of the common "riser"; which is a 24-in. galvanized spiral riveted pipe. It is provided with a 60-in. exhaust head.

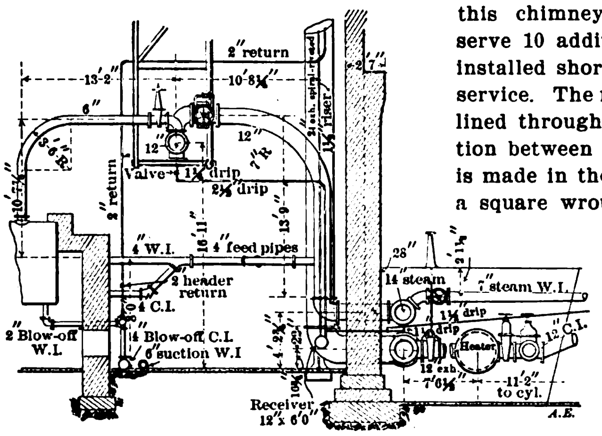


FIG. 3.—SECTIONAL VIEW SHOWING STEAM PIPING

Fifteen of the boilers are in the old boiler room and nine in the new one; Fig. 5 is a view in the new boiler room, and Fig. 6, shows the rear of the boilers in this room and illustrates the method of hanging the steam piping. Natural draft is employed. Just outside the old boiler room there is a chimney 150 feet high and having a flue 10 feet in diameter; in the corner of the new boiler room there is a chimney of the same height as the older one, but having a flue 12 feet in diameter, this chimney having been designed to serve 10 additional boilers which will be installed shortly, besides the nine now in service. The new chimney is of sheet steel, lined throughout with firebrick. Connection between the chimney and the boilers is made in the usual manner by means of a square wrought-iron flue, shown above the boilers in Fig. 5. There is, of course, the usual assortment of pumps for boiler feeding, and feed-water heaters. Fig. 4 is a diagram of the exhaust steam and feed-water piping in the new part of the plant. All of the heaters are of the well-known Wainwright design, built by the Taunton Locomotive Works, Taunton, Mass.

The newer electric generating equipment comprises two General Electric railway generators of 875 kilowatts capacity; two General Electric 125-volt machines of 200 kilowatts capacity each; two General Electric 125-volt generators of 100 kilowatts capacity each; one single-phase, revolving-field General Electric alternator of 215 kilowatts capacity, and three Brush multi-circuit arc-light dynamos, each having a capacity of 125 lamps. The railway generators are 12-pole machines, their speed being only 82 r.p.m., as noted in a previous paragraph. The 200-kw.

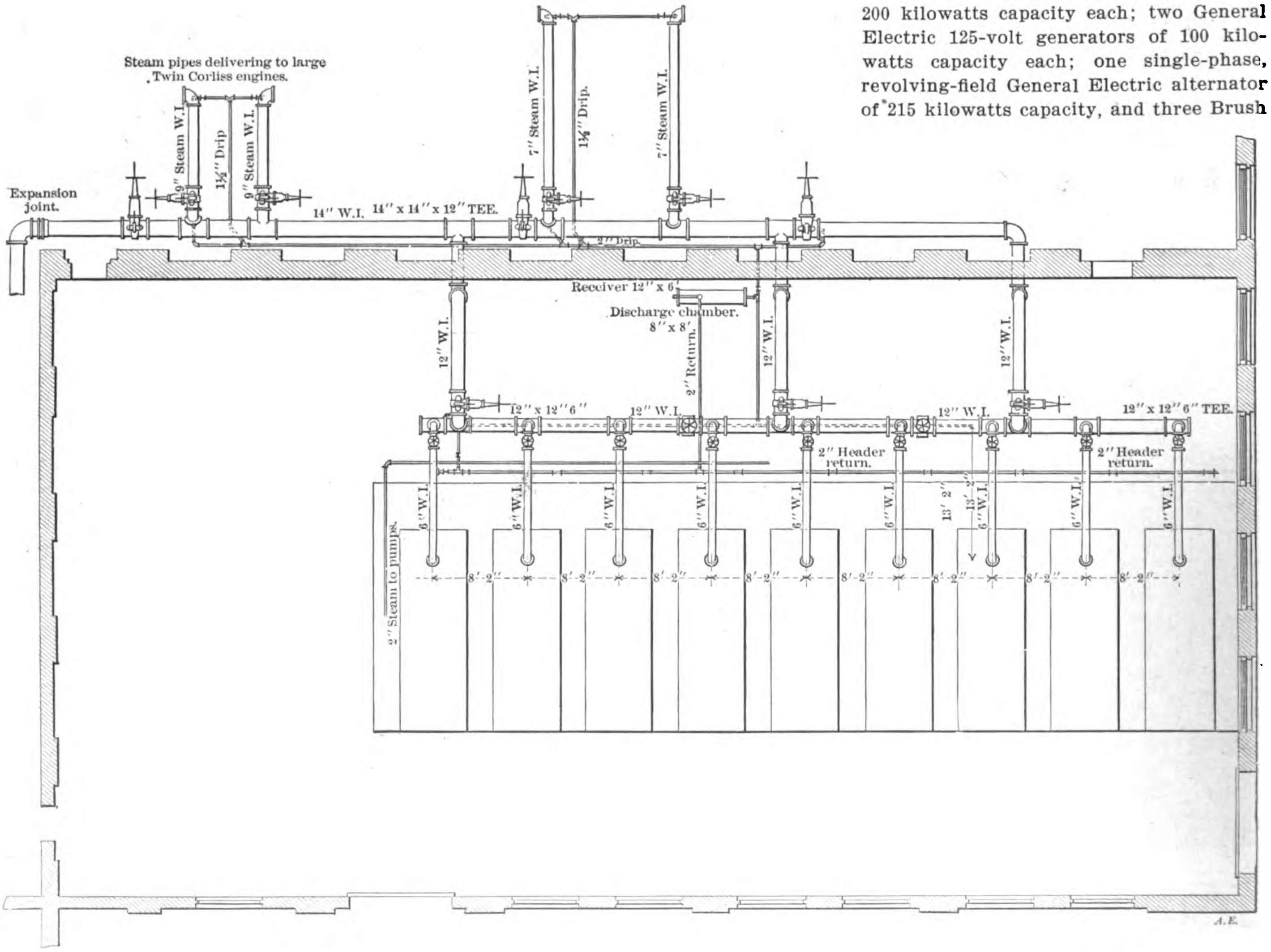


FIG. 2.—PLAN VIEW OF BOILER ROOM SHOWING GENERAL ARRANGEMENT OF STEAM PIPING.

125-volt dynamos driven by the 20-in. x 30-in. Corliss engines are 8-pole machines, and the two 100-kw. machines driven by the Harrisburg engine have each 6 poles. These machines are of the General Electric Company's standard types, so that a description of them is superfluous.

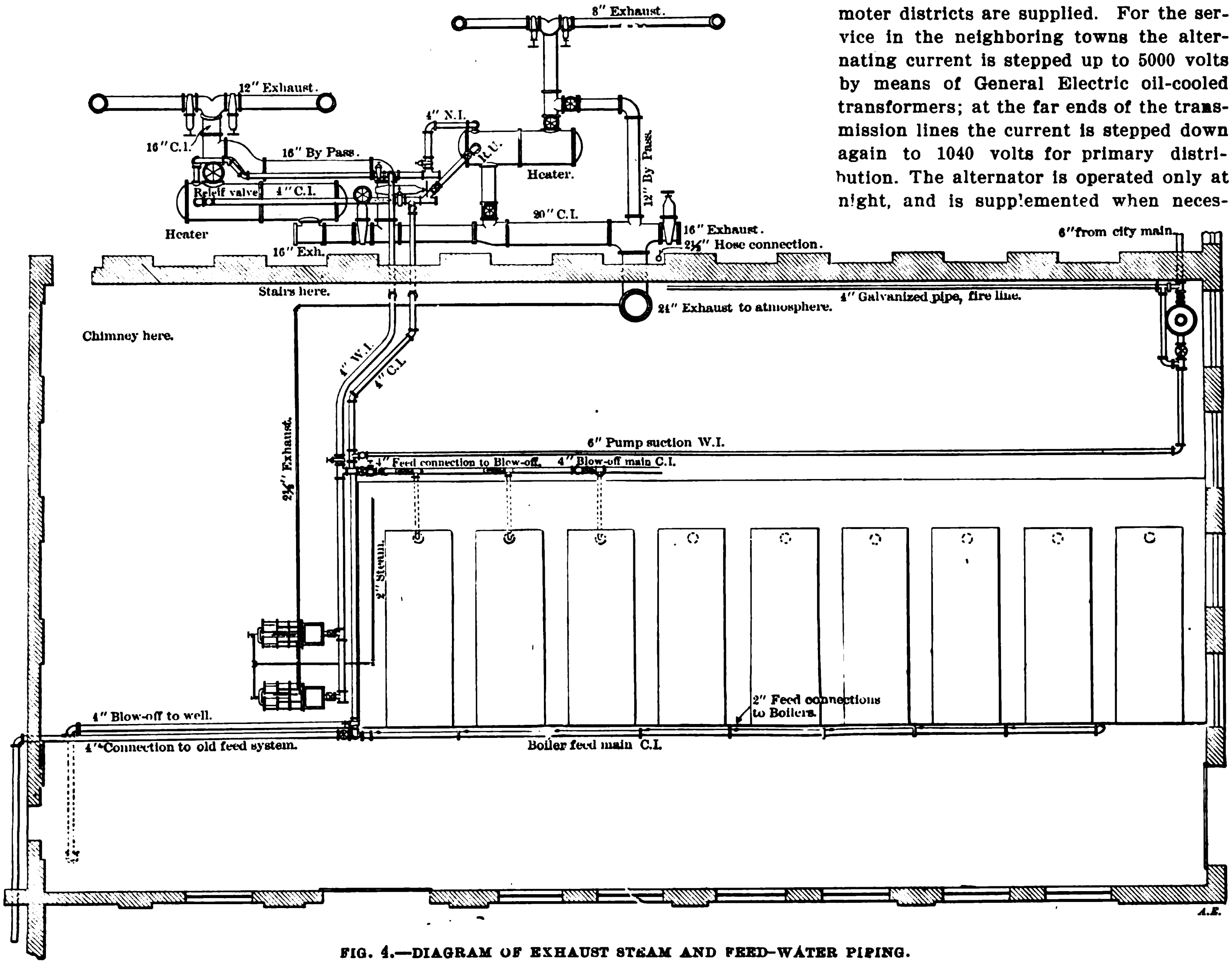


FIG. 4.—DIAGRAM OF EXHAUST STEAM AND FEED-WATER PIPING.

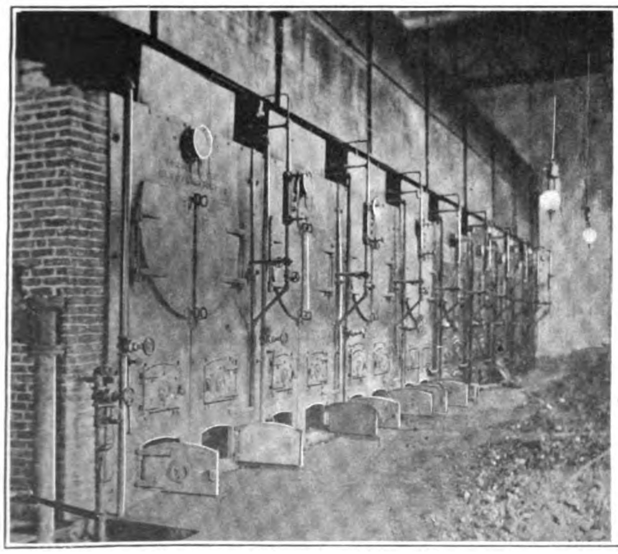


FIG. 5.—VIEW IN NEW BOILER ROOM.

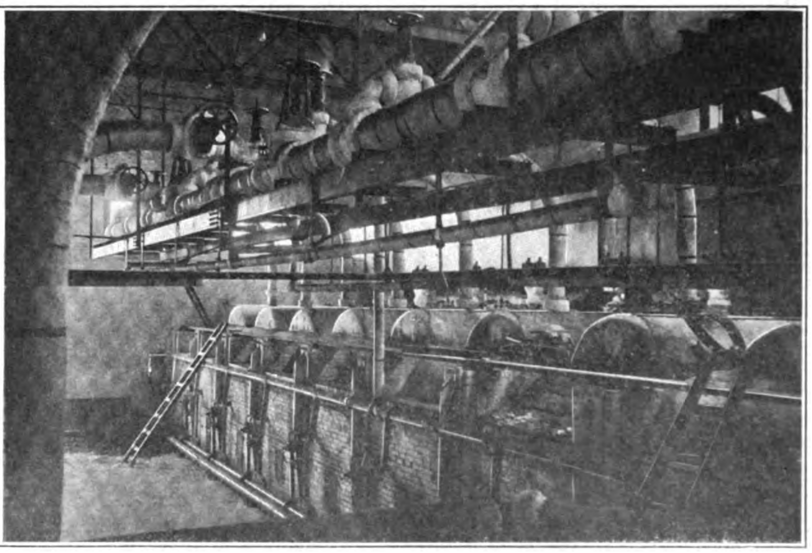


FIG. 6.—REAR VIEW OF BOILERS AND PIPING.

The railway generators supply current to the system of the Birmingham Railway & Electric Company. The 125-volt dynamos all deliver current to a three-wire distribution to which are connected up all of the incandescent and arc lamps for business lighting and as many of the residence incandescents as are within economical reach. All of the commercial arc lamps are of the enclosed-arc type. The single-phase alternator delivers current at 1040 volts to the local primary lines from which residence lights in the remoter districts are supplied. For the service in the neighboring towns the alternating current is stepped up to 5000 volts by means of General Electric oil-cooled transformers; at the far ends of the transmission lines the current is stepped down again to 1040 volts for primary distribution. The alternator is operated only at night, and is supplemented when necessary by a monocyclic machine which is included in a group of older-style apparatus belt-driven from the shafting previously mentioned. The monocyclic machine also runs during the day, the day load consisting largely of small motors.

The Brush arc-light dynamos supply

the street-lighting circuits, on which open-arc lamps are used exclusively. The lamps are equipped with prismatic globes and the results are greatly improved distribution of light, diminution of glare, and an almost complete suppression of shadows beneath the lamps, as compared with the ordinary clear globes. There are also several old-style arc-light dynamos of the T.-H. and Ball types, but these will be displaced by modern Brush machines in the immediate future.

The switchboard equipment is of standard character and conventional arrangement; Weston and General Electric instruments are used.

In the basement of the new part of the building there are located lamp and meter testing rooms, a repair shop, stock rooms, etc. There is down here an Ingersoll-Sergeant air compressor, driven by a direct-current motor, which supplies air under pressure for cleaning out the generator armatures and crevices about the field structures; compressed air is also used to operate a boiler tube cleaner. The motor that drives this compressor also drives an arc-lamp testing machine and the machine tools in the repair shop.

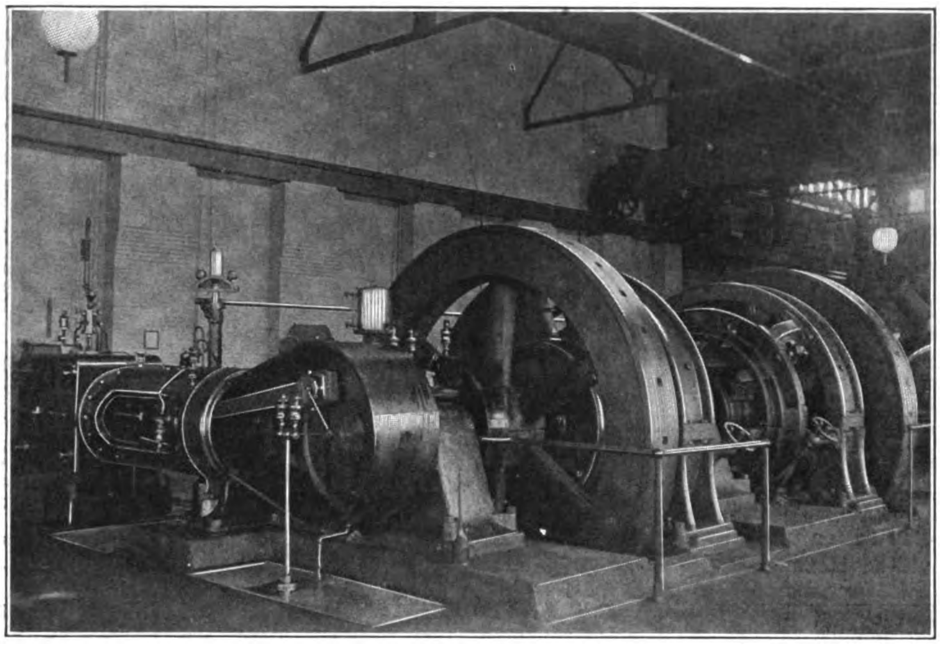


FIG. 7.—PARTIAL VIEW OF HIGH-SPEED GENERATING SET.

In order to take care of the rapidly-increasing demands for lighting service and to supply power to a railway line running to Bessemer, 12 miles distant, the company has arranged to install a 5000-volt three-phase alternator of ample capacity to cover future demands for some time to come; space for this machine has been left in the new part of the station. The current for lighting purposes will be stepped down by three-phase-two-phase transformers, so that the single-phase primary circuits now in use may be supplied from this source or from the older machines, according to the exigencies of the service. The current for the Bessemer railway will be stepped up for transmission, and after being stepped down at sub-stations, will, of course, go through rotary converters.

PARABOLIC REFLECTORS FOR SEARCHLIGHTS.

A parabolic mirror will concentrate at its focus incident light moving in paths parallel to its axis, or will reflect incident light diverging from its focus in plane waves perpendicular to its axis; consequently the parabolic reflector is peculiarly adapted for searchlights and head lights where concentrated and parallel rays are required. Mechanical difficulties in construction, however, have heretofore prevented the manufacture of mirrors or reflectors having surfaces other than spherical. A very simple and accurate method for making parabolic reflectors is the Cowper-Coles, which is entirely electrolytic, and the paramount feature of which is that the surface produced requires no after polishing or truing. The only serious item of expense is the production of a true mold; once this has been produced, any number of reflectors may be made from it at a comparatively small cost.

The first article necessary is a convex cast-iron mold having the curvature of a paraboloid, from which a concave mold is made of refractory material. Over this is placed a piece of flat glass about ¾ in. thick, and the whole placed in a kiln and heated to such a temperature that the glass will adapt itself to the curvature of the mold without fusing. The mold of glass thus prepared is then ground by emery wheels and polished with pads and rouge; the desired curvature being given to the mechanical feed by means of a template or gearing. This process of obtaining a perfect mold forms the main item of expense, two or three months being usually required with the largest sized reflectors.

After obtaining a suitable glass mold the next step in the process is to clean it and coat the convex surface with metallic silver. This may be done as follows: To a 55 per cent solution of silver nitrate, add sufficient ammonium hydroxide until the precipitate formed is dissolved. Reprecipitate with a 25 per cent solution of caustic soda, and again dissolve the precipitate in ammonium hydroxide. A solution of glucose is then added. The surface of the mold to be coated is immediately dipped, point downward, into this solution, and in four or five minutes silver is deposited, the solution changing from pink to dark brown and black. In thirty or thirty-five minutes the mold is removed, washed and dried, and the silver polished with cotton-wool and peroxide of iron which has been freshly precipitated by ammonium hydroxide from a weak solution of ferrous sulphate.

The glass mold is then placed in a suitable ring and frame and immersed in an electrolyte of copper sulphate, the percentage composition of which is 14 of copper sulphate to 3 of sulphuric acid and 83 of water. It should be immediately flashed with copper on immersion in the solution, and then rotated in a horizontal position at about 15 r.p.m., until a sufficient thickness of copper has been deposited. When this has been obtained, the mold is removed from the tank and placed in cold water, the temperature of which is then gradually augmented until a point is reached where, owing to the unequal expansion of the metal and glass, the reflector leaves the mold. The concave surface of the reflector thus obtained is an exact reproduction of the surface of the mold. It has a brilliant polish and requires no further treatment other than that of protecting the silver surface from tarnishing. A covering of platinum or palladium both serve this purpose, the latter being preferable. Its cost is almost double that of platinum, but its specific gravity being but half, the same area can be covered at relatively the same outlay. Both are deposited electrolytically; palladium from an ammonium-chloride solution of palladium, and platinum from a freshly precipitated solution of the double chloride of platinum and ammonium dissolved in a boiling concentrated solution of neutral citrate of sodium. Before being placed in either of these solutions, the back of the reflector is usually varnished to prevent local action, and the concave surface thoroughly washed in a weak solution of caustic soda which has been previously heated. When the deposit of platinum or palladium has been deemed to be sufficient the reflector is removed from the bath and dipped in hot water. It is then ready for mounting.

In making reflectors by this process it is essential that the glass mold should be perfectly clean and free from grease before being placed in the silvering solution. By purely chemical cleansing the silver is liable to adhere to the mold so firmly that in removing the reflector from the mold the latter is in danger of being broken. This difficulty may be overcome by cleaning the mold with peroxide of iron, and then washing it with a 50 per cent solution of ammonia. If the mold is first dipped in a solution of protochloride of tin and then washed before being placed in the silvering solution, the deposit of silver will be thicker, clearer, and more uniform.

THE SERVICE PLANTS OF THE PAN-AMERICAN EXPOSITION.

Electrical energy for the uses of the Pan-American Exposition is supplied from three plants. One of these is a sub-station for transforming power received from Niagara and the other two are steam plants generating power on the grounds. Power plant No. 1 is the Niagara sub-station in the northwest corner of Electricity Building. This sub-station contains eighteen 250-kw. General Electric transformers connected in for service and a nineteenth in reserve, making a working capacity of 4500 kilowatts. The output of this sub-station is used entirely on the decorative lighting of the grounds and exteriors of the buildings (except for a small amount used in Electricity Building), the amount expended in this direction being far in excess of anything heretofore used at an exposition in proportion to the space illuminated. This lighting is all done by 8-c.p. incandescent lamps and the current is supplied by the Niagara Falls Power Company, at a frequency of 25 cycles per second. This frequency is suited to incandescent but not to arc lighting; consequently, the current for lighting the interior of Electricity Building, which is done by enclosed arcs forming a part of the General Electric exhibit, is supplied by a 60-cycle generator driven by a 25-cycle motor, which receives current from the transformer plant.

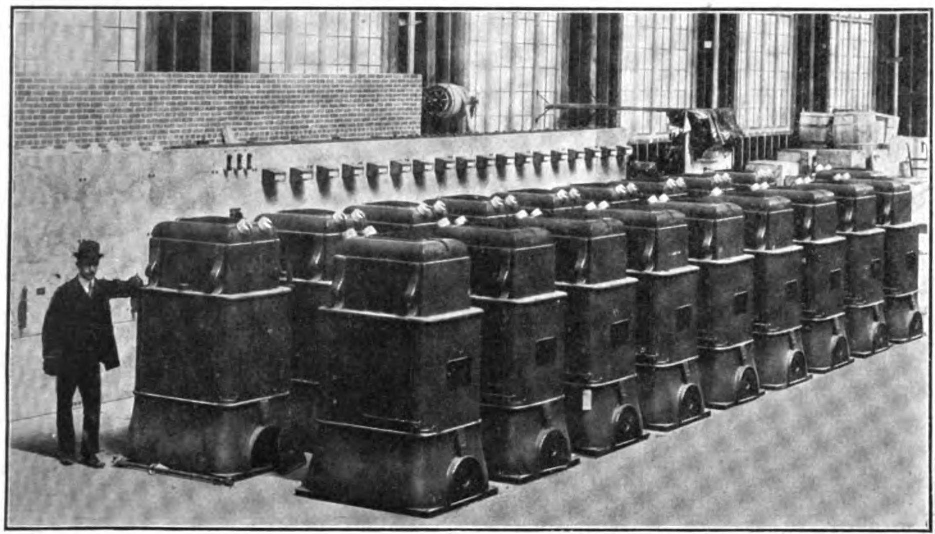


FIG. 1.—TRANSFORMERS IN THE EXPOSITION SUB-STATION; ELECTRICITY BUILDING.

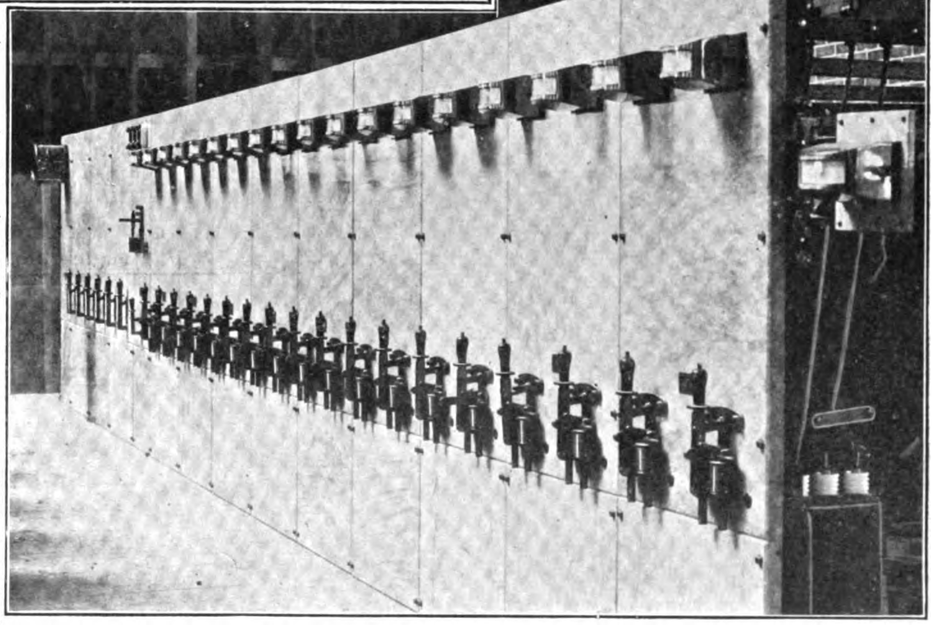


FIG. 2.—SWITCHBOARD IN THE NIAGARA SUB-STATION AT THE PAN-AMERICAN EXPOSITION.

The eighteen 250-kw. transformers, which are shown by Fig. 1, receive current from Niagara at about 11,000 volts three-phase and reduce it to 1800 volts three-phase for distribution about the grounds. At various points it is again reduced to 103 volts for the lamps. The transformers in No. 1 power plant are all air-cooled. They are located on the main floor over a brick vault in the basement; and a fan blower, also on the main floor, forces air into the air-tight vault at ½-oz. pressure. The main 11,000-volt circuit is opened by an electrically-operated oil switch and circuit breaker of a new type to be used on the Manhattan Railway in New York City. The six banks of transformers each have a hand-operated three-pole oil switch on the 11,000-volt side. On the secondary side all the transformers are connected in directly on the bus-bars and from the bus-bars 12 three-phase feeder circuits are led out, each of which has a hand-operated three-pole oil switch. In each of these feeder circuits there is an ammeter.

At lighting-up time in the evening all the decorative lights in the grounds and buildings are started at once, beginning with the dullest red glow of the filaments and rising gradually in about three-fourths of a minute to full candle-power. In shutting down they are reduced gradually also. This is accomplished by means of a water rheostat inserted in the 11,000-volt supply mains before they reach the sub-station in Electricity Building. This water rheostat is near the northwest corner of the grounds and is enclosed in a small frame house which, for safety, is mounted on posts about 15 ft. high. The rheostat consists of three cast-iron plates ¾ in. thick, each plate being pivoted at one end and arranged to be lowered into a tank of water. At the extreme lowest position of the plates the free ends engage with metal clips, making a complete metallic circuit. The plates in all three tanks are raised and lowered simultaneously by means of a small electric motor. They are of such a shape that the resistance is varied uniformly, so that as the plates are lowered the voltage comes up very gradually until all the resistance is cut out and the lamps are burning at full candle-power. The use of this water rheostat for bringing the lamps up to candle-power so gradually is important not only on account of the spectacular effect produced, but because it avoids throwing a huge load on the generating machinery all at once.

Power plant No. 2 is one which was built for service pure and simple and not for exhibition, although there is some exhibit apparatus in it. The equipment of this plant comprises one Stanley 300-kw. two-phase inductor alternator driven by a Phoenix Iron Works engine; one Westinghouse 180-kw. two-phase alternator driven by a Buffalo Forge Company engine; one 80-kw. Stanley frequency changer, changing from 25 to 60 cycles in order to enable Niagara current to be used on some 60-cycle apparatus; one Warren 180-kw. two-phase inductor alternator driven by an Armington & Sims second-hand engine; four Westinghouse 500-volt direct-current 225-kw. generators driven by second-hand Armington & Sims engines; two Westinghouse 90-kw. 110-volt direct-current generators driven by second-hand Armington & Sims engines; 16 No. 8 Brush arc machines driven by Armington & Sims engines. The 500-volt machines, of which there is a capacity of 1000 kilowatts in this plant, are used for supplying power around the grounds. The alternators all deliver current at 1800 volts and 60 cycles.

Just outside of the boiler partition in the engine and dynamo room are two Otis feed-water heaters of 3000 horse-power, made by the Stewart Heater Company, which are used to heat all of the feed-water for the power plant. These are furnished with exhaust connections for two 16-in. exhaust pipes, and suitable connections for feeding all of the steam boilers in the steam plant.

In the basement of the court of the Machinery and Transportation Building is located power plant No. 3, which is a combined service and exhibit plant. Here also are located some of the pumps which are on exhibition but are used for service pumping. This No. 3 power plant, which is still incomplete, contains two units installed by the D'Olier Engineering Company, of Philadelphia, which consist of Erie Ball engines direct-connected to 100-kw. Keystone dynamos. The current from these is used for the fountain searchlights around the electric tower nearby and the excess is used for lighting the interior of the court in the Machinery and Transportation Building. Motors in the Machinery and Transportation Building are run from an Onondaga Dynamo Company's 100-kw. 110-volt generator belted to a Skinner straight-line engine. An American Ball 110-volt generator direct-connected to an American Ball compound engine supplies current to constant-potential arc lamps in the Horticultural Building.

In the rear of the Machinery and Transportation Building, across the canal, is a boiler house which furnishes steam to the engines and pumps in the building. This plant contains four Morrin Climax boilers of 500 horse-power each under which natural gas is burned by means of Kirkwood gas burners, made by Tate, Jones & Co. of Pittsburg.

All of the wiring of the Exposition, except that for the arc lamps on the Midway, is carried underground in pump log ducts, that being the only feasible method with such an amount of energy to be distributed. The wire for the entire installation was furnished by the Safety Insulated Wire & Cable Company.

Commercial Types of Steam Superheating Apparatus.

BY GEO. A. HUTCHINSON.

TABLE I.—RESULTS OF TESTS ON STEAM ENGINES BUILT ON THE SCHMIDT PRINCIPLE.

Kind of Engine.	Performance in H. P. (Indicated).	Boiler Pressure in lbs.	Temperature of the Steam in Deg. Fahr.			Steam Consumption in lbs. per hr. I. H. P.	Coal Consumption in lbs. per hour. I. H. P.
			Saturated.	Superheated.			
				At Boiler.	At Engine.		
Simple horizontal two-cylinder non-condensing (single-acting)	129.4	158.4	359.6	705	664	16.87	2.59
	103.1	144.1	362.5	676	625	18.43	2.68
Horizontal tandem compound condensing	124.6	166.2	372.8	...	663	10.07	1.43
	117.9	167.6	372.9	...	664	9.76	1.43
	106.6	165.7	372.8	...	661	9.50	1.58
	104.9	165.6	372.8	703	654	9.99	1.55
	103.6	161.5	370.9	682	627	10.14	1.54
Compound; h. p. cylinder horizontal, l. p. cylinder vertical	118.9	160.2	369.5	640	...	10.57	1.81
	110.2	160.3	370.0	677	...	10.74	1.71
	71.95	108.4	342.5	677	...	11.41	1.83
	72.12	108.8	342.5	684	...	10.82	1.83
" " "	68.73	153.6	366.8	675	...	10.42	1.52
Vertical tandem compound condensing	75.32	169.2	374.4	675	651	10.17	1.28
	71.38	167.8	373.8	662	604	10.88	1.38
Compound; h. p. cylinder vertical, l. p. cylinder horizontal	110.15	124.1	351.9	...	582	12.5	1.99
	102.21	130.1	354.9	...	638	11.3	2.12
	109.79	131.4	355.9	...	645	11.5	2.17
Simple horizontal	64.97	91.7	332.2	531	...	21.7	3.55
Compound horizontal	34.13	113.7	345.9	568	...	18.5	2.01
Two-cylinder (single-acting)	46.45	142.2	361.4	651	...	20.3	2.18
Vertical two-cylinder (single-acting).	39.45	128.3	354.0	...	687	17.2	1.89
	40.90	127.1	352.4	...	694	16.5	2.13
Non-condensing	47.82	125.3	352.0	...	654	15.3	....
Horizontal compound	26.97	103.9	339.8	611	...	23.5	4.02
Simple horizontal	21.45	106.6	341.6	619	...	21.9	2.10
" "	22.36	125.1	352.4	667	...	15.0	2.37
" "	22.53	123.1	352.0	690	...	15.0	2.88
Vertical high-speed	16.57	105.2	339.8	572	...	19.4	2.79
Simple (single-acting)	4.47	114.5	345.9	...	684	21.0	3.49
	4.85	112.3	345.0	...	702	20.5	3.25
Horizontal cross-compound	184.2	140.	359.6	745	558	10.4	1.31
	124.8	140.	359.6	without superheat		17.2	2.10
Twin tandem compound condensing (single-acting)	257.6	157.3	369.2	728	665	8.97	....

The Schmidt system of utilizing superheated steam, which is referred to frequently as resulting in the highest efficiency yet attained with the steam engine is designed especially to attain the theoretical gain due to a high initial temperature, a temperature which is impracticable with the ordinary engine. The steam is heated to 660° Fahr., and an engine of a special type is built to use it. Fig. 2 shows a boiler with feed-water heater, economizer and superheater as built under the Schmidt patents by the Aschersleben Maschinenbau A. G. The economizer consists of eight tiers containing five coils each of spirally-wound 2-in. pipe. Directly above are eight tiers containing four coils each of 2¾-in. pipe constituting the superheater. Placed on a higher level is the feed-water heater, which is a simple cylindrical vessel containing a coil of pipe. The feed water enters the heater at the bottom, and is discharged by a pipe near the top into the boiler. The lower end of the heater coil is connected with the lower end of the economizer coil, and the upper ends are also connected together, and to the steam space in the boiler.

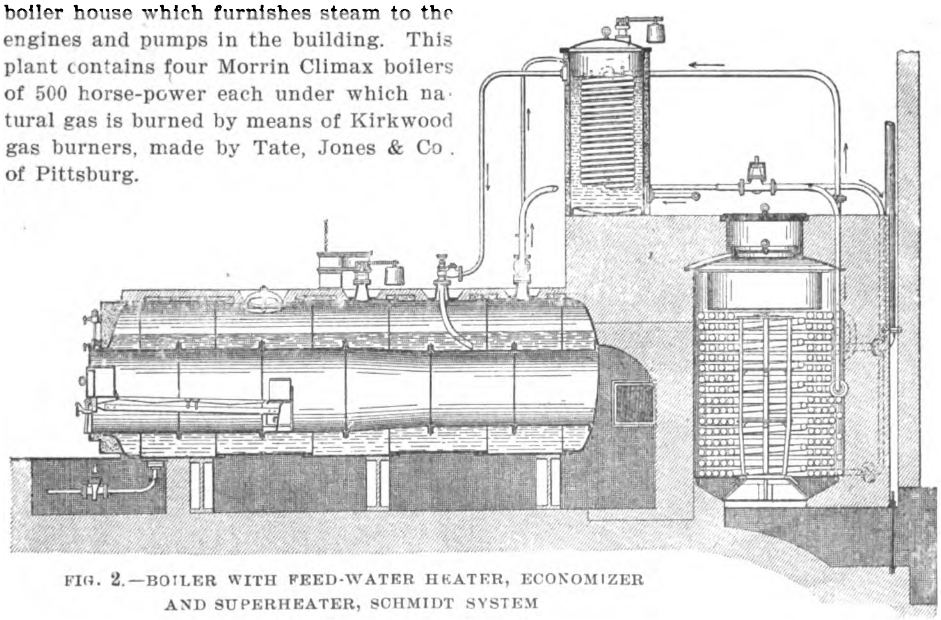


FIG. 2.—BOILER WITH FEED-WATER HEATER, ECONOMIZER AND SUPERHEATER, SCHMIDT SYSTEM

Steam entering the heater coil is condensed, imparting its heat to the surrounding water, and then, flowing to the economizer, it is re-evaporated and returned to the top of the heater coil to repeat the cycle indefinitely. The use of distilled water in this manner obviates the danger of the economizer becoming filled with mud or scale, and the heater is of such a form as to be readily accessible and easily cleaned. A feed-water temperature of 260° equivalent to a boiler pressure of 20 lbs., may be attained under favorable conditions.

The economizer and superheater are arranged with a view to using the heat of the gases completely, and, by a combination of a parallel and a counter-current flow of the steam through the superheater, to protecting it from destruction by the hottest gases. The path of the gases of combustion is downward, first through the superheater, and then through the economizer, leaving the latter at a temperature of 350° to 400° Fahr. In order to utilize the counter-current principle as far as desirable, the wet steam enters the lower part of the superheated coil and flows upward through four tiers. Should the counter-current principle alone be applied, an economical use of the gases would be assured but that part of the superheater which was in contact alike with the hottest gases and the hottest steam would deteriorate rapidly. Accordingly, the steam is led from the fourth tier to the eighth, or upper tier, and passing down parallel to the flow of the gases is withdrawn from the fifth tier. The steam, dried in the lower coils, is supposed to reach the upper tier in this condition and become superheated by the hottest gases, which are just entering the apparatus. The degree of superheat can be controlled by dampers regulating the flow of the gases of combustion, that portion not passing through the coils being applied to the boiler heating surface.

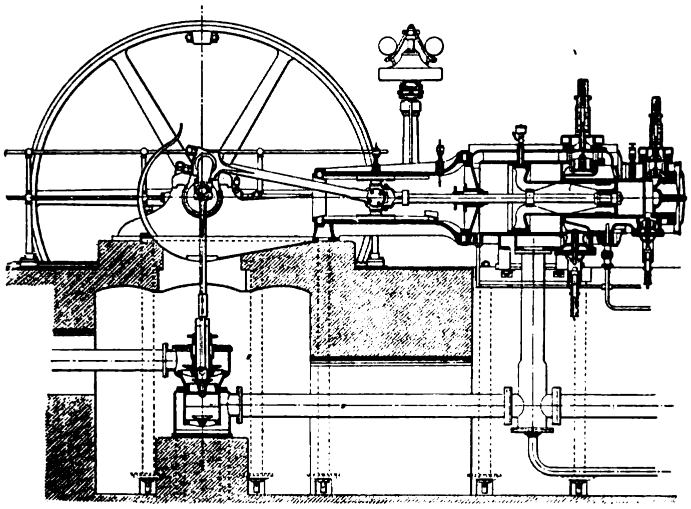


FIG. 3.—SCHMIDT TANDEM COMPOUND ENGINE.

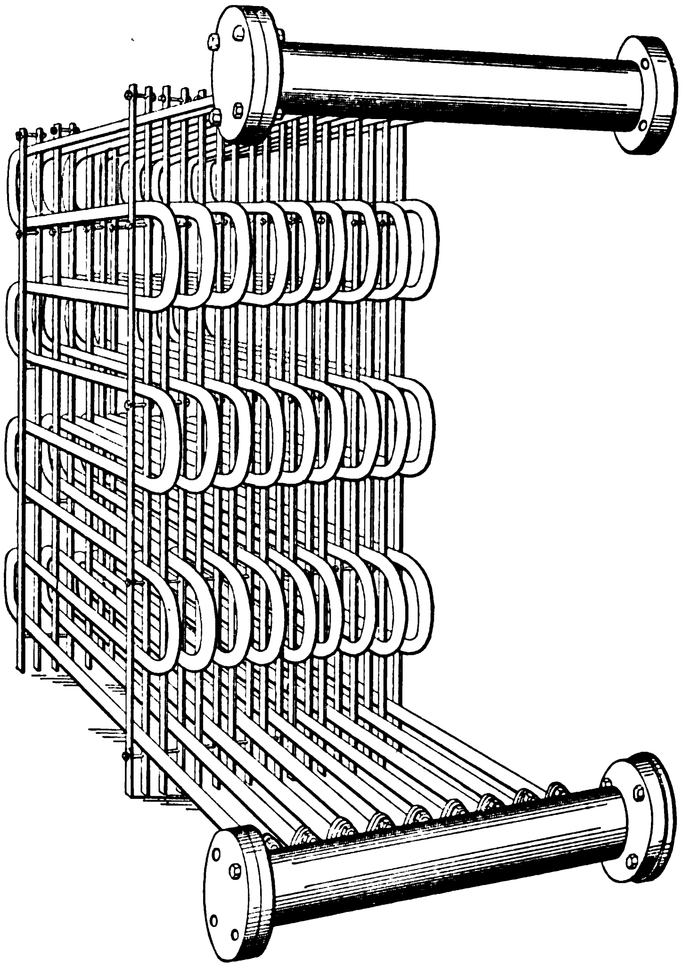


FIG. 4.—ARRANGEMENT OF TUBES IN HERING SUPERHEATER.

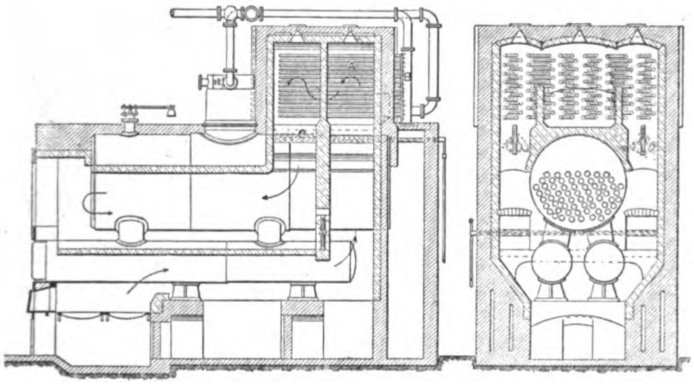


FIG. 5. -HERING SUPERHEATER APPLIED TO ELEPHANT BOILER.

The Schmidt tandem compound engine for superheated steam, as built at Aschersleben, is shown by Fig. 3. The engine is nominally single-acting with the high-pressure cylinder behind. The high-pressure and low-pressure pistons are cast in one piece, which is hollow. The space at the rear of the large piston, encircling the small trunk piston, constitutes the low-pressure cylinder, while the jacket on the large cylinder and the space in front of the piston, together with the piston's hollow interior, form a receiver having a varying volume. During the inward stroke the steam in this receiver expands and does some work, so that the engine in reality is double-acting. This construction requires a single stuffing-box, which is exposed to low-pressure steam only, and the hollow piston forming part of the receiver is kept comparatively cool, while any heat transferred is not lost but taken up by the low-pressure steam. Poppet valves are used.

Simple engines built after the Schmidt design are single acting, and therefore have no stuffing-box. The trunk pistons are made very long, and the packing rings placed well forward, so that for much of the stroke they are in contact with a portion of the cylinder which is exposed to the atmosphere during part of each revolution. They never reach that part of the cylinder which is exposed to the highest steam temperature. Cross compound engines to use steam at such high temperatures are built with single-acting high-pressure cylinders, and are made double acting on the low pressure side, since all of the superheat disappears in the first cylinder.

TABLE II.—SUMMARY OF TESTS OF A 3000-H. P. SULZER ENGINE.

Tests Using Steam.	Highly Superheated.			Moderately Superheated.	Saturated.	
Boiler pressure in pounds (absolute).	196.8	199.9	198.4	199.9	202.8	202.8
Initial pressure in high-pressure cylinder (absolute)	187.3	195.5	188.4	190.3	194.6	195.9
Temperature of steam in valve chest	582	585	614	531	381	381
Total indicated horse-power............	2,900	2,779	2,868	2,850	2,951	2,999
Pounds of steam per horse-power-hour	9.64	9.67	9.56	10.29	11.77	11.75

Engines and superheaters are built under the Schmidt patents by several concerns, and, of course, there is considerable variation in the design. Balanced piston valves are used instead of poppet valves, and vertical boilers with a provision for controlling the degree of superheat by admitting to the superheater coil condensed steam from the coil in the feed-water heater. These boilers have very low ratios of water heating surface to grate surface, and in some cases the evaporation is as high as 10 pounds of water per square foot of heating surface per hour. Very wet steam is wanted to protect the superheater.

A few results from numerous tests on Schmidt engines are given in Table I, in English units. These tests were made by various authorities and reported to different German societies. Most of the tests were made on small engines, but Schmidt engines are in use which develop 1000 horse-power and more. Some results of tests on a 3000-h.p., four cylinder, vertical, triple-expansion Sulzer engine, using steam from Schmidt independently fired superheaters, are summarized in Table II for convenient reference.

The arrangement of the coils in the Hering superheater is shown in Fig. 4. The tubes are small in diameter and long, and are made of Swedish steel without welds. Ordinarily steam temperatures of 450° to 550° are attained, though temperatures as high as 800° can be used.

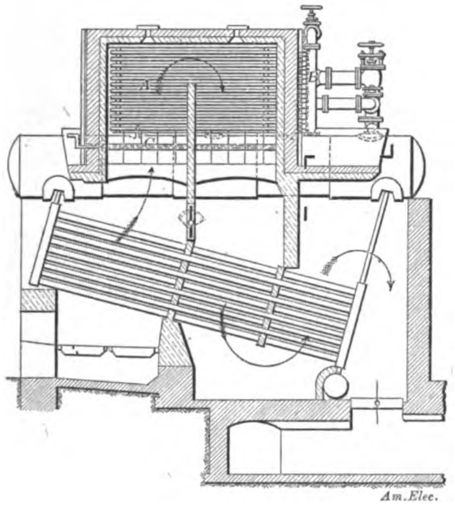


FIG. 6.—HERING SUPERHEATER APPLIED TO WATER TUBE BOILER

Fig. 5 shows the superheater as applied to an elephant boiler. The hot gases leaving the grate heat the lower side of the mud drums, then pass up around the boiler shell near the rear end into the superheater, thence down around the front portion of the boiler shell, and return back through the fire tubes to the chimney. The drawing shows an arrangement of dampers by means of which the flow of gases can be controlled completely, or shut off altogether from the superheater, in which case they will be applied as economically to the water heating surface as though no superheater were present. The application to a water-tube boiler as in Fig 6 is similar. By adjusting the dampers, this boiler also can be operated efficiently either with or without the superheater.

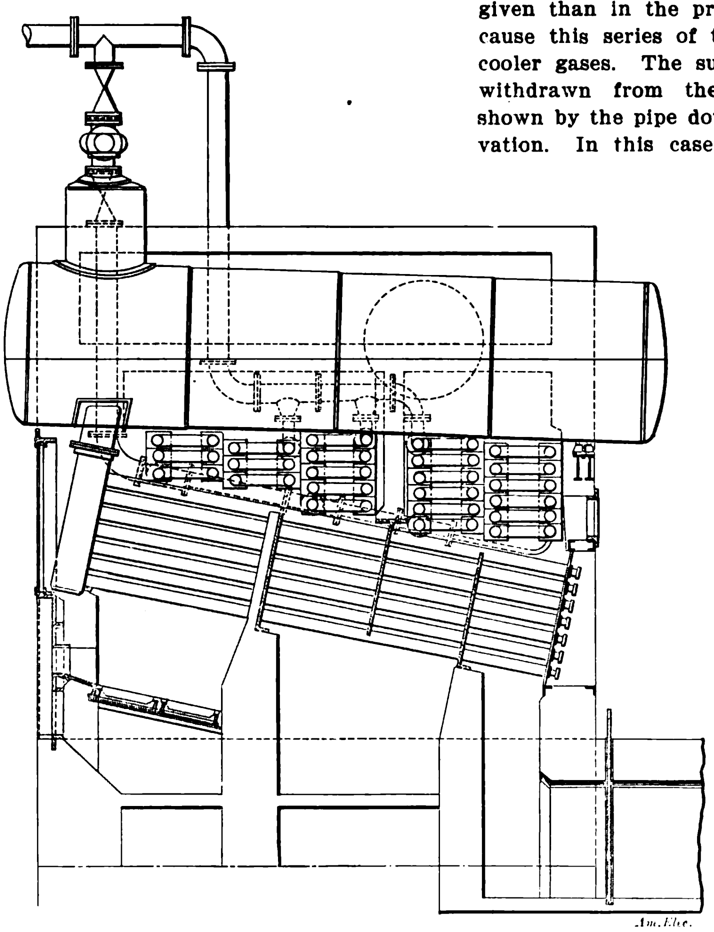


FIG. 7.- WATER-TUBE BOILER FITTED WITH WALTHER SUPERHEATER

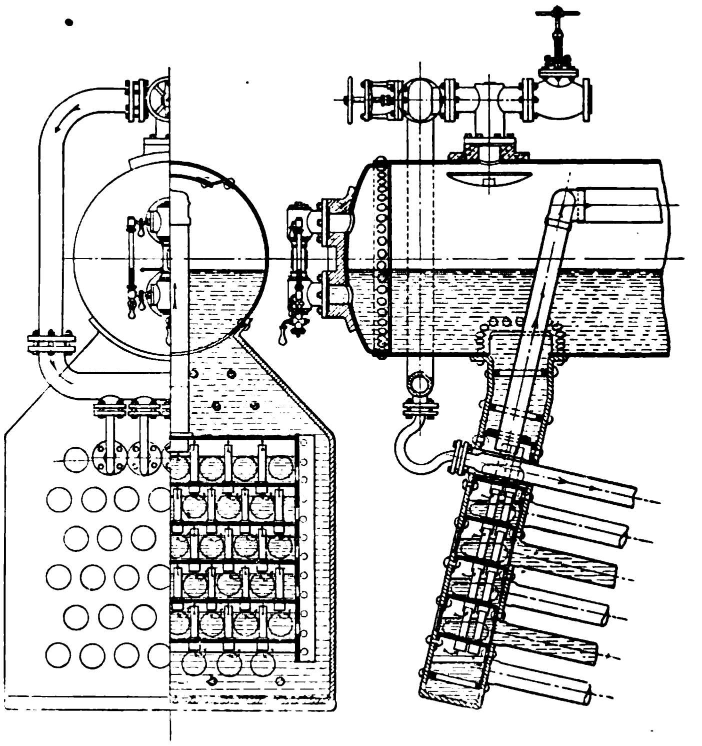


FIG 8.—GEHRE SUPERHEATER APPLIED TO WATER-TUBE BOILER.

Hering superheaters of double effect are built for use with compound engines. The steam is moderately superheated before entering the high-pressure cylinder, and again, before entering the low, as much as is necessary to prevent condensation during admission.

Fig 7 shows a water-tube boiler with superheater, as built by Walther & Co. Thin, mild steel tubes are used. The location of the baffle plates is clearly shown, and indicates that the gases make four passes over the water tubes. Steam from the drum above flows down through the pipe at the side, and a portion is drawn through the six U-shaped tubes which the gases encountered after they first pass through the water tubes. Another portion of the steam goes through the bank of five tubes beyond. The entrained water, and the remainder of the steam circulate through the last bank of twelve tubes, where more heating surface is given than in the preceding groups, because this series of tubes is exposed to cooler gases. The superheated steam is withdrawn from the three groups as shown by the pipe dotted in the side elevation. In this case the steam divides into three portions, each of which traverses throughout its whole length a group of pipes, forming one section of the superheater.

The Gehre superheater, as adapted to a water-tube boiler, is shown in Fig 8. The boiler has water legs made of sheet steel stayed with channel irons riveted between each tier of water tubes. Through each channel project, above and below, a series of nipples, the whole being contrived so as to form at the end of each row of tubes, a small water chamber, with a steam pocket above. The nipples make free communication between these steam pockets, so that steam generated in any tier of tubes can easily reach the steam drum above without meeting any obstruction.

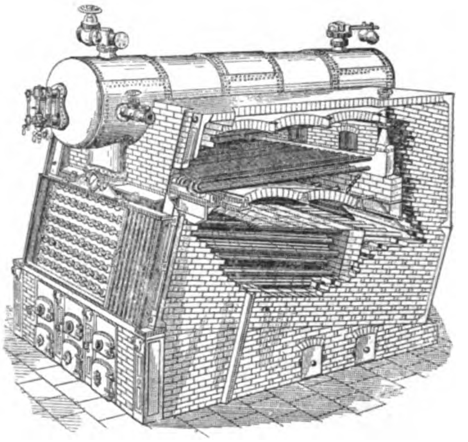


FIG. 9.—STEINMUELLER SUPERHEATER.

A row of water tubes is omitted, and sleeves, carried through the water legs, allow three or four small superheating tubes to pass through each sleeve into headers outside, thus removing all joints from the fire. Wet steam enters the front header, and superheated steam is withdrawn from the rear. If a high degree of superheat is desired, two tiers of superheating tubes are put in, so that the steam makes a double pass. With the ordinary horizontal fire tube boiler, a series of coils is placed in the combustion chamber at the rear, so that the gases pass over them before entering the flues which lead to the uptake. In either type provision is made for flooding the superheater with water. Temperatures of 180° to 270° above the saturation temperatures are usually attained.

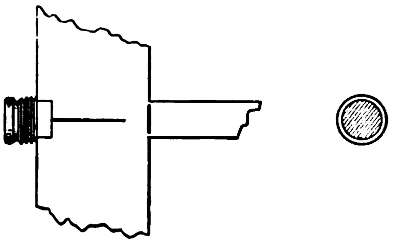


FIG. 10.

The Steinmüller superheater, Fig. 9, is made up of a series of U-tubes, 1 5/16 inches internal diameter, which terminate in a two compartment header placed at the back of the boiler, between the steam drum and the water tubes. The gases reach the superheater after making a single pass through the water tubes. Brick arches and dampers are so placed that the superheating tubes can be isolated from the flue gases if necessary. In the header there are openings provided with suitable screw plugs in the outer wall opposite the tube ends, as illustrated by Fig. 10. The plugs for that compartment which the wet steam enters are provided with stems bearing little disks which serve to choke the entrance to the superheating tubes, retard the flow, prevent short circuiting and increase the heat absorption of a given weight of steam without increasing the heating surface unnecessarily. The discharge end of the U-tube is left unrestricted.

The Reisert superheater presents novel features, inasmuch as the attempt is made to equalize the degree of superheat by means of an increasing velocity of flow of steam through the apparatus, and by a special provision for mixing the current. The superheating tubes are arranged similarly to those in the Steinmüller, and many other superheaters. The important difference is found in the header shown in Fig. 11. The wet steam enters at *A*, flows through the U-tubes 1, 1′, 2, 2′, and 3, 3′ back to the hood K_1, thence through 4, 4′ and 5, 5′ to K_2, then through 6, 6′ and 7, 7′ to K_3, through 8, 8′ to K_4, next through 9, 9′ to *R*, and from *B* out to the engine. The hoods K_1, K_2, K_3 and K_4 have the wet steam on the outside and the superheated on the inside, so that there is no pressure difference. It appears that the steam flows through three tubes, then through two, and finally through one, so that, if its initial speed is 50 ft. per second, the speed rises to 75 ft., and then to 150, increasing with the superheating temperature, because, as it becomes more like a perfect gas the frictional loss diminishes.

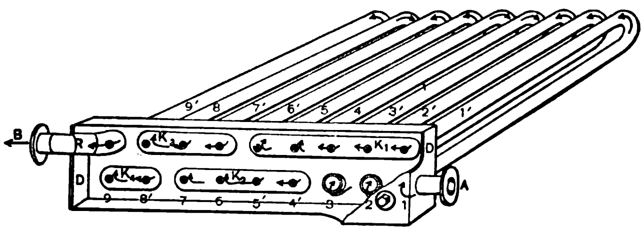


FIG. 11 —HEADER OF REISERT SUPERHEATER.

To facilitate the mixture, a device, shown in Fig. 12, is placed within each tube, to turn the cooler central portion of the current against the wall and the hotter external portion into the center of the tube. The superheater can be filled with water in case of necessity, and a damper is located so that more or less of the gases can be short-circuted, and the temperature thus regulated.

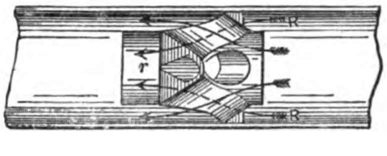


FIG. 12.—MIXING DEVICE IN REISERT SUPERHEATER.

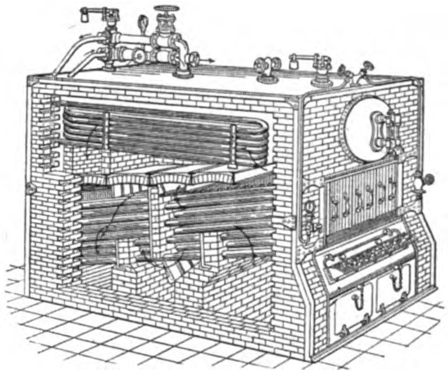


FIG. 13.—MEYER'S SUPERHEATER.

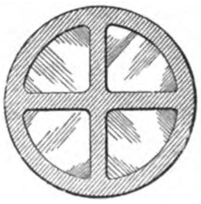


FIG. 14.—SECTION OF TUBE, MEYER SUPERHEATER.

Fig. 13 illustrates the arrangement of a superheater adopted for water tube boilers by B. Meyer. It is placed in duplicate at each side of the steam drum, above the water tubes, with brick arches so located that by the use of dampers the superheating can be controlled or the apparatus can be cut out altogether. The superheater consists of a long, thick-walled, seamless tube, made of soft steel, through which the steam makes a single pass from one end of the coil to the other. A cross section of the tube is shown by Fig. 14. It is divided into four passages throughout its length by partitions the better to transmit the heat taken up to the center of the current of steam, and to effect a complete superheating with a small number of coils, an ample cross-sectional area and consequent low rate of flow, with little loss of pressure. The partitions have a helical twist in order to give the current a twisting motion, and throw any contained moisture against the hot outer walls, and keep their temperature within safe limits.

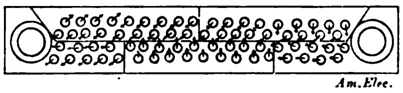


FIG 16.—HEADER OF SIMONIS & LANZ SUPERHEATER.

The superheater illustrated by Fig. 15 was designed by Simonis & Lanz, and is interesting on account of the arrangement of the baffle plates and dampers. The header, into which the wet steam is led, is shown in Fig. 16. It is plain that steam entering the upper left hand compartment will pass through the U tubes into the compartment below, then through other tubes into the upper middle space, next to the lower right hand compartment, and finally to the upper right hand compartment and out. The steam generated in the boiler takes a sinuous passage through a separator in the steam drum, and, the valve *G* being closed, flows through the valve *C* to the left hand portion of the lower header, and through the superheating coils

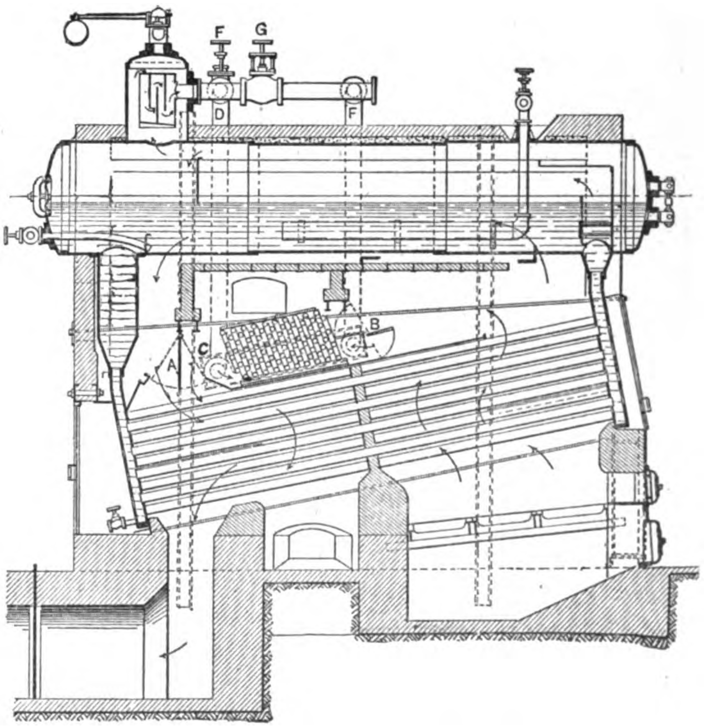


FIG. 15.—SIMONIS & LANZ SUPERHEATER.

in the manner described, becoming thoroughly mixed.

Above the superheating coils is a tile floor extending along under the middle part of the steam drum, and above the water tubes are baffle plates which control the direction of flow of the gases. Dampers are placed at *A* and *B*. By manipulating the back dampers at *B*, any desired proportion of the gases can be sent through the superheating coils, or around them, and in contact with the steam drum above, before reaching the rear end of the water tubes. By closing the dampers at *A* and *B*, the superheater can be completely isolated without diminishing the water heating surface of the boiler in the least.

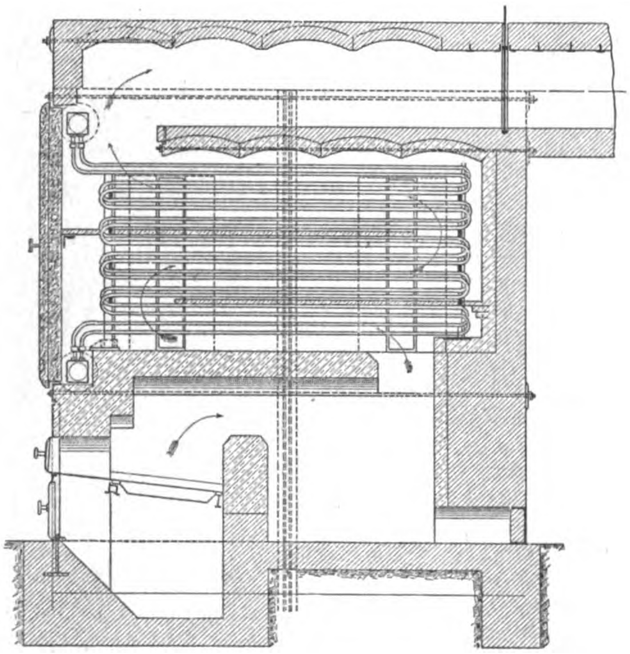


FIG. 17.—BUETTNER INDEPENDENTLY-FIRED SUPERHEATER.

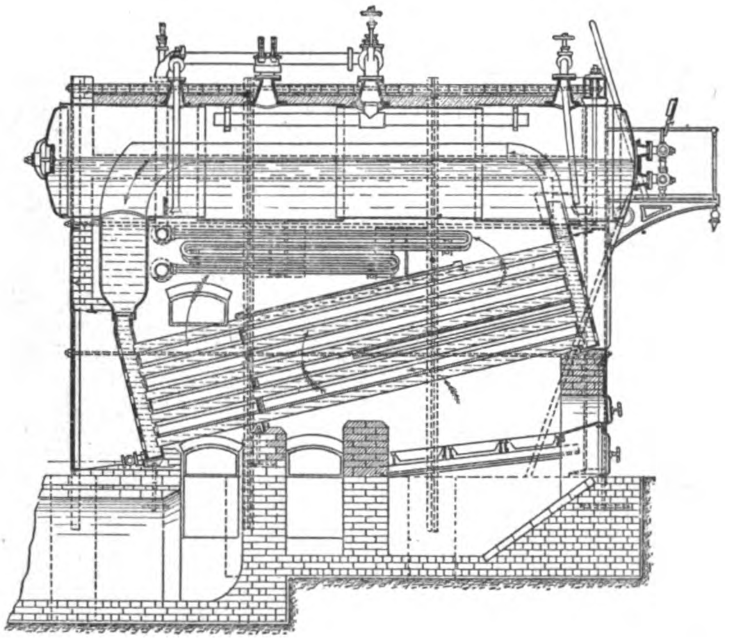


FIG 18.—BUETTNER RAPID-CIRCULATING BOILER FITTED WITH SUPERHEATER.

The arrangement of a Büttner independently fired superheater is shown by Fig. 17. The steam enters the header at the top, and dividing into a number of small currents, passes through the coils forward and back ten times, till it collects in, and is discharged from, the lower header. The builders use mild steel tubes made with very thick walls. Their method of setting a superheater with a water tube boiler is illustrated in Fig. 18. It is very similar to the practice of Babcock & Wilcox. An interesting feature of the boiler is the insertion of a trough in the steam drum, connecting with the water legs front and back, to afford an unobstructed path for the water which rises with the steam in the front leg, and thereby to maintain a rapid circulation.

In the Göhrig & Leuchs'sche superheater, Fig. 19, the parallel and countercurrent principle is adopted. Steam is admitted at each end of a series of coils, and is withdrawn at the middle, with the same intent as in the Schmidt system. The arrangement of piping here, as indeed with many types, permits the use of saturated steam, of superheated, or of a mixture of the two.

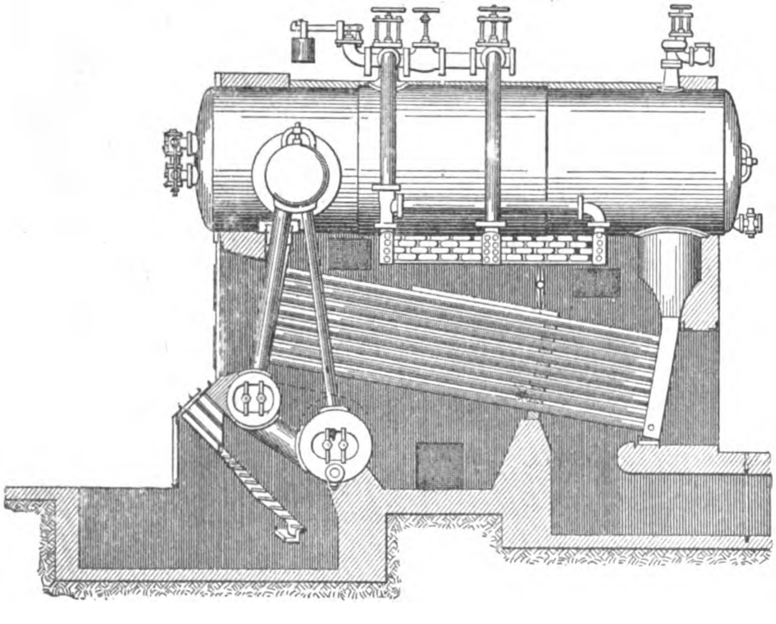


FIG 19 —GOEHRIG & LEUCHS'SCHE SUPERHEATER.

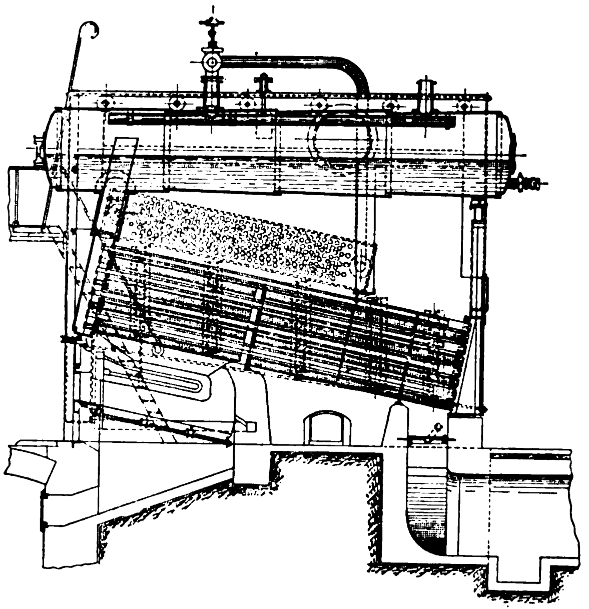


FIG. 20.—DUERR WATER-TUBE BOILER WITH SUPERHEATER.

The Dürr superheater, as built with a water tube boiler, is shown in Figs. 20 and 21. The tubes are so placed that the flow of the gases of combustion is across instead of parallel to them, a detail often thought to be advantageous. Since, with this boiler, field tubes are used, dispensing with a water leg at the back, a superheater can be located as in the Büttner design to good advantage, if it is so desired. The header has five compartments, so that the current of wet steam entering the first is split up in numerous small tubes, reunited and well mixed in the next compartment, split up by another series of tubes, and so on until the last compartment is reached.

The Göhring superheater recommends itself by reason of the ease with which, in case of necessity, a new element can be substituted for an old one. As Fig. 22 shows, it consists of a series of spiral coils of soft steel pipe. The ends are brought outside of the boiler setting, and connected by means of bolted flanges to headers. Fig. 23, indicates a method of applying it to a double decked boiler, with provision for isolating it.

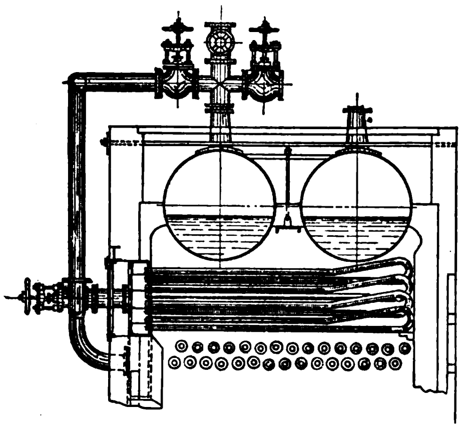


FIG. 21.—DUERR SUPERHEATER.

Some excellent features are embodied in a superheater patented by R. Hildebrand and shown in Fig. 24. Steam from the pipe *g* enters a separator *G*, and flows thence to the headers *C* and *D*, which connect directly with the superheating coils, *A* and *B*. A three-way valve, *E*, controls the distribution of steam to the two coils, and a by-pass, *h*, permits the water from the separator to flow into the coil *A*, which is exposed to the hottest gases. In the coil *A* the steam flows in the same direction as the gases of combustion, while in the coil *B* it flows in the opposite direction, the parallel and counter-current principle of Schmidt being here introduced. The rear coil being exposed to cooler gases, is longer than the front coil. By controlling the distribution at *E*, an approximately equal temperature in both members should be attained. The superheated steam is withdrawn at *H*.

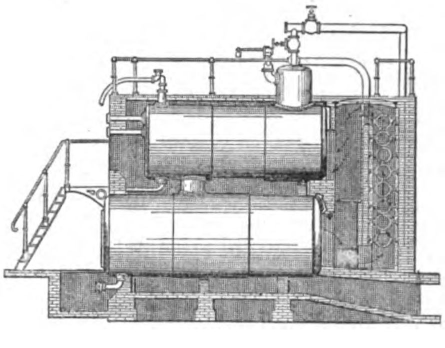


FIG. 23.—GOEHRING SUPERHEATER APPLIED TO DOUBLE-DECKED BOILER.

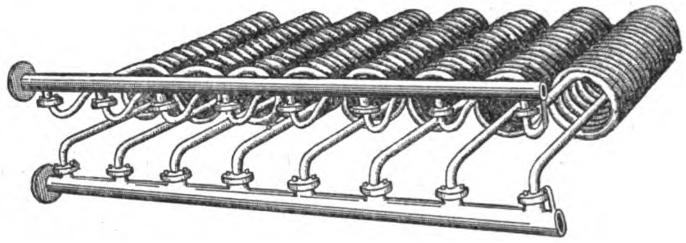


FIG. 22.—GOEHRING SUPERHEATER.

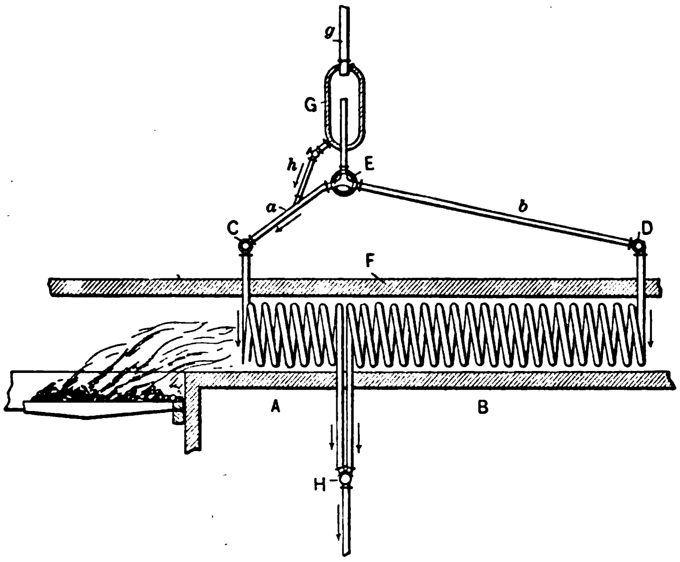


FIG. 24 —HILDEBRAND'S SUPERHEATER.

In the Fehrmann superheater, shown by Fig. 25, the steam to be superheated is contained in an annular space between a 7-in. and a 10-in. pipe. The larger pipe is worked down to a suitable size at the ends, and a tight joint secured by welding. The hot flue gases pass through the inner tube, and around the outer. Between the tubes are corrugated strips of sheet copper bent into a cylindrical shape, the corrugations being parallel to the axis of the cylinder, the strips pressing by their own elasticity against both the inner and the outer shell. To secure a better mixture of the steam passing over these plates, they are so arranged that the crests of the corrugations on one plate are in line with the hollows of the adjacent plates. Since copper has six or seven times the heat conductivity of iron, and since there are numerous lines of close contact between the corrugated plates and the inner and the outer tubes, the additional heating surface thus obtained should be very effective.

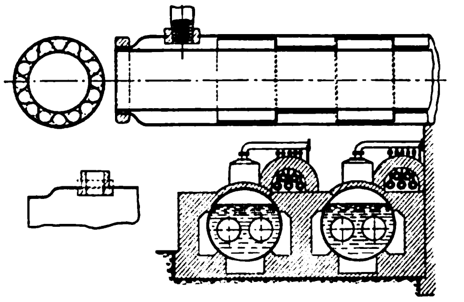


FIG. 25.—FEHRMANN SUPERHEATER.

The engraving shows how this apparatus may be applied to an old boiler with little or no interruption to its regular operation. By providing a short cut to the chimney through the superheater, it is possible to control the flow of gas, and the arrangement indicated permits of its being easily thrown out of use whenever it is desirable to do so.

The Schwoerer superheater is shown in Fig. 26 applied to an internally fired boiler. A glance at the end view shows that it is placed in the side flues where the gases are making their second pass over the water heating surface. It is made up of 10-ft. lengths of cast-iron pipe, ribbed outside circumferentially, and inside longitudinally, to split up the current of steam into small parts, which is important because of its low heat conductivity. The intention is to provide ample heating surface internally and externally, with a compact apparatus, and, by means of the excess metal, to store or give out heat as the flue temperature fluctuates, so as to

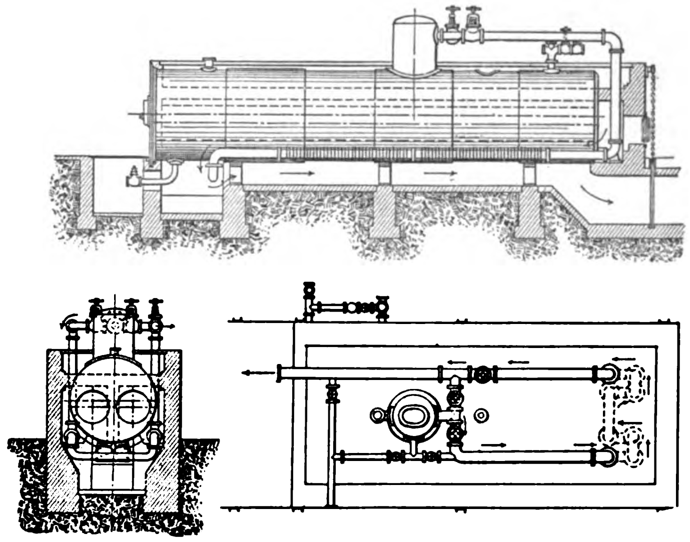


FIG. 26.—SCHWOERER SUPERHEATER APPLIED TO A LANCASHIRE BOILER.

equalize the steam temperature, which is, in fact, kept fairly constant. A temperature of 750° can be safely maintained.

Dampers are considered unnecessary, and are installed only in exceptional cases. The joints are flanged, and shaped to let in a ring of special form imbedded in a refractory cement, and then drawn up with bolts. They are said to be absolutely tight under all conditions of temperature and pressure.

Fig. 27 represents a cast-iron superheater built by Böhmer Brothers of Magdeburg. The elements are ribbed externally, and have a single interior wall extending almost to the far end of the element, which is closed, so that the steam passes along one side and returns through the other, inlet and outlet being at the same end of the casting. Perfectly free expansion, and tight joints, are thus secured with little trouble.

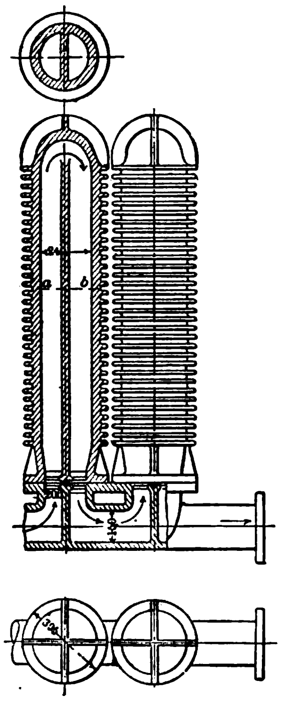


FIG 27. – BOEHMER SUPERHEATER.

The types here illustrated serve to show the variety of ways in which the problem of superheating steam has been attacked. Such types as the Schmidt, the Schwoerer, the Gehre, the Walther, and the Hering have been in the market long enough to demonstrate their utility, and hundreds of installations have been made of each type, indeed of over 2000 of the Schwoerer. Others have yet to stand the test of time, and one, the Hildebrand, so far as the writer knows, has not yet been built at all. The fact that almost all of the leading boiler makers in Germany to-day find it necessary to have some sort of a superheater to offer is a sufficient indication of the tendency of the times.

[The foregoing is an extract from a paper read before the Milwaukee meeting of the American Society of Mechanical Engineers.]

STEAM TABLES.

BY CHAS. L. HUBBARD.

Before taking up the study of steam tables and their application to practical examples in engineering it is necessary that a few fundamental principles of heat and steam be thoroughly understood. First, what is heat? There have been many theories in regard to this, but the accepted theory at the present time is that it consists of a vibration of the molecules of the substance, and the degree of heat depends upon the velocity and amplitude of the vibrations.

The terms hot and cold are only relative—that is, we say a thing is hot, but the expression does not state how hot it is. In order to determine just how hot a body is we must compare its temperature with that of some substance whose intensity of heat we know.

The most simple way of doing this is to use some substance whose volume changes a definite amount with the addition or removal of a definite amount of heat, and always has the same volume for the same degree of heat. A substance having the above property is placed in a glass bulb, to which is connected a tube with small bore. As heat is applied to the bulb the substance expands into the tube; marks or lines are made on the tube at the height the substance stands when it has a certain degree of heat. In order to make the comparison we place the tube, which is called a thermometer, in contact with the body whose degree of heat we wish to know, and then note the height of the mercury or other substance which was placed in the bulb. We say two bodies have the same degree of heat when no heat will pass from one to the other when they are placed in contact. Therefore, the reading of the thermometer indicates the temperature of the body with which it is in contact, but cannot indicate the amount of heat it contains.

For example, a small iron bar may be heated to a white heat and still contain but a small quantity of heat as compared with that contained in a larger bar at a much lower temperature. The unit of heat is taken as the quantity of heat required to raise the temperature of one pound of pure water one degree at its point of greatest density, which is at about 39° Fahr. The quantity of heat required to raise 1 lb. of water through successive degrees is not quite constant, but increases slightly as the temperature of the water rises. For all practical purposes, however, we may neglect this and define a heat unit, or British Thermal Unit (B. T. U.), as the quantity of heat required to raise 1 lb. of water 1° Fahr.

The substance most commonly used in thermometers is mercury, although air, water, alcohol and other substances are used under different circumstances. The scale in most common use is known as the Fahrenheit scale, and the graduations are obtained by noting the position of the mercury column when the bulb is placed in melting ice, and again when placed in steam which is being evaporated under atmospheric pressure. This difference in the height of the column is divided into 180 equal parts, and one of these is called a degree.

Although a body cannot become hotter unless heat passes into it or is generated in it, heat may pass into some bodies under certain conditions and still not raise their temperatures; the making of steam is an example of this. Suppose we have a vertical cylinder fitted with a piston, which is free to move up and down, but which may be loaded as much as we please. Suppose there is a certain quantity of water—1 lb., for instance —in the bottom of the cylinder, and the piston rests upon its surface. If heat be applied to the cylinder by a gas flame or by a fire the following effects will be noticed: First, the temperature of the water will gradually rise, until it reaches a point at which steam is first formed. Second, when steam begins to form the piston will rise, exerting a steady and constant pressure, but although the fire continues as hot as ever, the temperature of the water and steam remains the same as when the steam first began to form. Steam formed in this way in the presence of water is called "saturated" steam. This state continues until all the water has been evaporated, the temperature remaining constant all the time. Third, after all the water has been evaporated the piston will still rise and the temperature, which has remained constant while steam was forming, will again begin to rise. The steam is then said to be superheated.

If there had been a different load on the piston, so that there would have been a different pressure on the water and steam beneath, the temperature at which the steam was formed would have been different; if the pressure had been increased the temperature would have been higher. If the water had been open to the atmosphere steam would have been formed when the water reached a temperature of 212°. It has been shown by experiment that there is a definite relation between the temperature and the pressure exerted by saturated steam—that is, for every pressure there is a corresponding and fixed temperature. There is no such direct relation between the temperature and pressure of superheated steam. Superheated steam at 60 lbs. gauge pressure may have any temperature above 307°. At a given pressure the temperature and volume for a given weight of superheated steam are always greater than the temperature and volume of the same weight of saturated steam.

Steam in contact with water is always saturated, and if any water is present in the steam in the form of a mist the steam is said to be wet. If there is no water present in this form it is called dry.

Returning to the illustration of the

cylinder, it will be remembered that while the steam was forming, the temperature of both water and steam remained constant, although more heat was being supplied all the time. This heat, which apparently disappears in the formation of steam, is said to be "latent," and when the steam is condensed it is given out again. The amount of heat which becomes latent in changing the water into steam decreases as the temperature at which the steam is formed increases.

Examining a steam table giving the properties of saturated steam one finds either a part or the whole of the following headings to the columns.

1. Pressure above a vacuum in pounds per square inch.
2. Temperature in degrees, Fahr.
3. Heat in the liquid, above 32 degrees Fahr.
4. Internal latent heat.
5. External latent heat.
6. Latent heat of evaporation.
7. Total heat of evaporation.
8. Weight of a cubic foot of steam in pounds.
9. Volume of a pound of steam in cubic feet.
10. Ratio of volume of steam to volume of equal weight of water.

Now let us take these up briefly in order and see what each means. (1.) The pressure shown by the steam gauge is 14.7 pounds less than the actual pressure inside the boiler, for the pressure of the atmosphere is acting on the outside of the gauge and the pointer indicates only the difference between the internal pressure and that of the atmosphere, so that 14.7 pounds must be added to the gauge reading to get the absolute pressure inside the boiler. All comparisons in which ratios occur should be made in absolute pressures. Some steam tables give the absolute pressure while others give gauge readings.

(2.) As above stated, saturated steam under a given pressure always has the same temperature. The temperatures corresponding to different pressures have been accurately determined and recorded, so that by knowing the pressure one can find the corresponding temperature at once from a steam table, or the temperature being given, the pressure is found in the same manner.

Columns 3, 4 and 5 may best be explained by reference to the illustration of the cylinder. (3.) This shows the number of heat units that have been used in raising the temperature of the water from 32 degrees Fahr. to that at which steam is formed for the pressure taken.

(4.) The internal latent heat is that which has been expended in work in the process of evaporation, which is the tearing apart of the particles of water against molecular attraction.

(5.) The external latent heat is used in the work of expansion, which was the work required to raise the piston and weight in the illustration of the cylinder.

(6.) The latent heat of evaporation is the sum of the internal and external latent heats, and would again be given out should the steam be condensed. This is sometimes called the latent heat of steam, or heat of vaporization.

(7.) The total heat of vaporization is the whole quantity of heat required to raise the water from 32 degrees Fahr. and evaporate it into steam at the pressure taken, and is equal to the heat in the liquid plus the internal and external latent heat.

(8.) This quantity, called the density, shows the weight in pounds of one cubic foot of steam at the pressure taken.

(9.) This column gives the volume of one pound of steam at the given pressure, and is called the specific volume.

(10.) The quantities given in this column are sufficiently explained in the table. In the experiment described the piston rose in the cylinder when heat was applied. We know that raising the piston must have required work; therefore, the heat applied must have performed work, and conversely, heat is produced when work is done. If two pieces of wood are rubbed together they become hot. Other examples of the generation of heat by work are found in the bearings of machinery, cutting tools, etc. In the steam engine hot steam is admitted to the cylinder, it does work on the piston, and is discharged cooler than it entered; heat has disappeared and work has been done. It is plain that when work is done *on* a body heat is generated in it, and when work is done *by* a body some of its heat disappears. Experiment shows that when a certain amount of work has been done by a hot body a certain amount of heat has disappeared.

This subject has been investigated with great care, and it has been found that the ratio of the unit of heat to the unit of work is constant. That is, if 778 foot-pounds of work are done on a body enough heat may be generated to raise one pound of water one degree Fahr. This equals one thermal unit. Conversely, if a hot body—steam, for example—does work, one thermal unit will disappear for every 778 foot-pounds of work done. This number, 778, is called the heat equivalent of work, or the mechanical equivalent of heat.

Having taken up the different quantities given in a steam table, and having become familiar with their meanings, let us see how this knowledge may be applied to the solving of practical examples. 1. If a wrought-iron pipe coil gives off two heat units per square foot of surface per hour for each degree difference in temperature between the steam in the coil and the surrounding air, how many square feet of radiator with steam at 80 lbs. gauge pressure will be required to give the same amount of heat as 1000 sq. ft. of radiator with steam at 2 lbs. pressure, the air in the room being at a temperature of 70° in each case?

Referring to a steam table, one sees that the temperature of steam at a pressure of 2 lbs. gauge (16.7 lbs., absolute) is 218.4° Fahr., and that of steam at 80 lbs. pressure is 323.8° Fahr., $219.4^\circ - 70^\circ = 149.4^\circ$, which is the difference between the temperature of the coil and the surrounding air. Then from the conditions of the example $149.4 \times 2 = 298.8$, which is the number of heat units given off by 1 sq. ft. of radiating surface per hour, and is called the efficiency of the radiator or coil. If steam at 80 lbs. pressure should be carried in the coil, the efficiency would become $(323.8 - 70) \times 2 = 507.6$ heat units per square foot per hour. In the first case, with steam at 2 lbs. pressure, the total number of heat units given off by 1000 square feet of surface would be $298.8 \times 1000 = 298{,}800$. If steam at 80 lbs. pressure gives off 507.6 thermal units per square foot of surface then the square feet of surface required to give off the same amount of heat as 1000 sq. ft. with a pressure of 2 lbs. would be $298{,}800 \div 507.6 = 588$.

2. If a bare steam pipe gives off 2 heat units per square foot of external surface per degree difference in temperature per hour, and only 0.4 of a B. T. U. when covered with magnesia covering, what will be the difference in weight of condensation per hour in a 12-in. steam main 120 ft. long carrying steam at 100 lbs., gauge pressure and exposed to a temperature of 20° Fahr.? 2-a. If 9,000 heat units are utilized per pound of coal in making steam, how many pounds of coal will be saved per hour by covering the pipe?

The external surface of a pipe of the above dimensions is 400 sq. ft. The temperature of steam at 100 lbs. pressure is 337.8°, therefore $(337.8 - 20) \times 2 \times 400 = 254{,}240 =$ the heat loss for the bare pipe. Similarly, $(337.8 - 20) \times 0.4 \times 400 = 50{,}848 =$ the heat loss when the pipe is covered; then $254{,}240 - 50{,}848 = 203{,}392 =$ the saving in heat units (B. T. U.) per hour by covering the pipe. We also find from the steam table that the latent heat of evaporation for steam at 100 lbs. pressure is 875.4, which means that 1 lb. of steam is condensed for every 875.4 heat units that are given off. Then the difference in weight of condensation per hour when the pipe is covered is $203{,}392 \div 875.4 = 232$ lbs.

Taking up the second part of the example, we have found that covering the pipe effects a saving of 203,392 heat units, and if 1 lb. of coal represents 9,000 heat units imparted to the steam, then the coal saved per hour will be $203{,}392 \div 9{,}000 = 22.5$ lbs.

3. A surface condenser receives 1,260 cubic feet of steam per minute at an absolute pressure of 10 lbs. (4.7 lbs. below atmosphere); how many gallons of injection water will be required per minute if it enters the condenser at a temperature of 40° and leaves it at 100°, and the condensed steam is discharged into the hot well at a temperature of 110°?

Looking in a steam table we find that a cubic foot of steam at a pressure of 10 lbs., absolute, weighs 0.026 lb., and its temperature is 193°. Then $1260 \times 0.026 = 32.7$ lbs., which is the total weight of steam to be condensed per minute. The table also tells us that the latent heat of evaporation for a pressure of 10 lbs. is 979.2—that is, 979.2 heat units must be extracted from each pound of steam to condense it into water at the same temperature; and to cool it to a temperature of 110°, $193 - 110 = 83$ B. T. U. more must be extracted. Therefore, $(979.2 + 83) \times 32.7 = 34{,}733.9$ heat units must be absorbed per minute by the injection water. If the water is raised from 40° to 100°, then each pound takes up $100 - 40 = 60$ heat units and $34{,}733.9 \div 60 = 578.8$ lbs. will be required. A gallon of water weighs approximately 8.3 lbs., so that $578.8 \div 8.3 = 69.7$ gallons will be required per minute.

PULVERIZED FUEL.

BY R. A. DOUGLASS.

A great many plans have been proposed for utilizing the waste from coal mines, and in particular, much attention has been given to the enormous piles of it that have accumulated around Scranton and in other hard coal districts. Special grates have been invented for burning such refuse, and schemes have also been devised for transforming it into gas, and for pressing it into briquettes (or "eggettes"), which are to be burned on ordinary grates, like coal of the larger sizes. The briquette idea has not met with general favor, probably because the expense of manufacturing the briquettes brings the cost of the fuel too nearly up to that of good coal. I may remark, in passing, that the conception of these vast beds of anthracite waste or "culm" that is entertained by the uninformed is in large measure erroneous. It is common to hear them described as though they consisted entirely of combustible material which would be available as fuel if the problem of burning it economically could only be solved. As a matter of fact, a considerable part of the culm consists of slate—that is, the coal which is richest in slate is that which finds its way to the culm pile. Further than this, it may be said that almost all of these vast accumulations of culm are on fire internally, and have been burning slowly for many years. This is shown by the faint columns of smoke that are sometimes seen rising from the banks, and by digging down into them a few feet it is often possible to expose layers that are red hot. These internal fires are undoubtedly of spontaneous origin.

Notwithstanding these facts, there is, of course, a great deal of the culm that is combustible, and if the culm accumulations are left out of account entirely there is still a vast amount of coal that is almost unsalable because of its fineness and the consequent difficulty of handling it; and many inventors have given their attention to the problem of utilizing fuel of this sort. The idea of pulverizing it and delivering it to the furnace in the form of a finely-divided powder, together with the proper amount of air for its combustion, is by no means new; experiments of this sort were carried out in Prussia fully seventy years ago. But like other fruitful ideas, this one had no important effect on industrial conditions for many years, because the earlier inventors could not pulverize the coal cheaply enough to have it compete with more expensive fuel. In fact, as recently as eight or ten years ago, engineers regarded the use of pulverized coal as an interesting possibility only; while now it is generally admitted to be full of promise, and there is reason for believing that plants using pulverized fuel will be quite common in the near future.

The advantages that are claimed for pulverized fuel by its advocates are these: (1) It is possible to use a cheaper grade of fuel without a corresponding loss in the efficiency of the boiler; (2) the fuel can be burned so that little or no smoke will be produced; (3) the process effects a considerable saving in the amount of hand labor required about the boiler room, resembling the automatic stoker in this respect; (4) it also resembles the automatic stoker in doing away with the necessity of opening the fire doors from time to time, and so letting cold air strike against the heated boiler; (5) and lastly, the system possesses the very important advantage that the air supply can be adjusted so nicely to the quantity of fuel used that the combustion can be made to take place under almost ideal conditions.

As already intimated, the greatest difficulty in the way of realizing these possibilities in the past has been the expense of grinding the coal to the requisite fineness. It is claimed that this objection has now been practically overcome, and that the fuel can be properly ground at an expense not exceeding twenty-five cents a ton. The writer has seen the claim made that the grinding can be done for as little as ten or fifteen cents a ton, but does not think this could be realized in practice, especially if there was much slate in the coal. Twenty-five cents is probably a fair estimate of what can now be actually accomplished.

Grinders have been devised which will handle the coal wet, but it is more common to pulverize it in the dry state. The grinding is usually divided into two operations, the first of which reduces the coal to about the size known as "buckwheat." If the coal contains more than a small proportion of moisture, it is then dried, after which it is reduced by the second operation to a fine powder, which should at least pass through a 150 mesh. Some operators prefer it to be reduced to the form of an impalpable powder before it is introduced into the furnace.

In Germany, where a good many experiments on this subject have been made, it is the practice to pulverize the fuel in considerable quantity, transporting it from the storage bins to the boilers in bags. In this country, however, it is far more common to avoid the storage of the pulverized coal by grinding it as it is needed and delivering it to the boilers directly. The writer is of the opinion that it is safer to pursue the latter plan; for, although he cannot recall any case in which coal pulverized for fuel has exploded or given rise to a serious fire, it is by no means sure that such accidents are not likely to occur. It is of interest to note that it was an explosion of a somewhat similar material that first directed the attention of one of our American inventors to the possibilities of pulverized coal. This gentleman was a manufacturer of foundry "facing," which consists of charcoal pulverized so finely that it will readily pass through the meshes of closely-woven cloth. An explosion occurred one day in his factory from the sudden combustion of charcoal dust, with the result that one entire side of the building was blown out. The thought struck him that if charcoal became so exceedingly inflammable by mere reduction to the form of dust, a similar treatment of coal might produce a fuel which would burn freely and without smoke, even when the coal to be thus treated was of an inferior quality; and acting upon this suggestion, he has developed a complete system for the use of pulverized coal.

The methods that are at present employed for burning pulverized fuel may be divided into two general classes, according as they use natural draft or require a blast of compressed air. In the first case a common method is to cause the powdered coal to fall in a thin sheet down through a slit which extends across the front of the furnace. The air, drawn in by the natural draft of the chimney, picks up the coal dust and delivers it to the furnace. In the air-blast method the coal dust falls down a vertical pipe across the bottom of which the air blast is passing; it is blown into the furnace in the form of a jet, which burns in very much the same manner as a jet of oil fuel or of natural gas.

One of the important things to attend to in using pulverized fuel is to see that the coal particles are entirely consumed while they are still floating in the furnace gases; for if they fall to the bottom of the combustion chamber before they are entirely consumed there is likely to be a considerable waste of fuel. This feature is not difficult to secure in practice. Perhaps the hardest thing to secure is the correct proportion of air and fuel for perfect combustion. This will require some little experience on the part of the fireman; but after he has once learned the management of the fire it should be easy for him to regulate the air supply very nicely, so that the combustion can take place under conditions more nearly ideal than is possible in the case of a boiler fired by hand, with coal of ordinary sizes.

In using pulverized coal under a boiler that was originally set for the use of ordinary coal, it is convenient to retain the grates, so that the boiler can be fired in the usual way in case of accident or the disabling of the pulverizing machinery. The grates are also useful for starting the fire when pulverized coal is used, a light wood fire being built upon them for this purpose. After the fire is well started there is little likelihood of its "snapping out," because the hot walls of the furnace will relight the stream of coal dust, even if it should be extinguished for a moment. It is not well to trust implicitly to the relighting powers of the heated walls, however, and care should be taken to maintain the fuel supply as uniform and continuous as possible. If the dust supply is momentarily stopped for any reason, and it does not immediately relight when it is turned on again, the same precautions should be followed in getting the furnace into action once more that would be followed in the case of oil or gas. That is, the fuel supply should be shut off and the furnace be allowed to ventilate for a few moments. A handful of oily waste should next be ignited and placed in the path of the fuel, which may then be turned on again. When the walls are hot this treatment ought to cause the dust to relight without any difficulty.

It may be thought that the care here suggested is unnecessary; but many bad accidents have occurred from the neglect of just such a simple precaution. I cannot refer to any in connection with the use of pulverized coal, but they certainly have happened with oil and gas, and it is a good plan to take every precaution in connection with coal dust, since it is so new a thing that we do not know yet just what precautions are unnecessary. In order to allow the dust to be completely burned before falling to the bottom of the combustion chamber a rather long flameway should be provided. Moreover, the flame should never be allowed to strike directly against any part of the boiler, because this is likely to give rise to overheating, especially if there is the least deposit of scale or oily matter on the inner surface of the boiler where the flame strikes it. It is a good plan to arrange a pier or arch of firebrick directly in front of the flame, when the air-blast system is used, placing it far enough away so that there shall be plenty of time for the dust to be burned before striking the pier. This causes the heat to be properly diffused without taking the smallest possible chance of injuring the boiler from overheating.

The ash from pulverized fuel is exceedingly fine and light, and much of it is likely to be drawn up the stack and distributed about the neighborhood if care is not taken to check this tendency. A generously large combustion chamber at the back of the boiler will prevent this trouble in large measure, because it will decrease the velocity of the gases sufficiently to allow the greater part of their burden to be deposited. The ash which settles in the back connection is so fine that it may be drawn off through a pipe by means of a blower.

One claim that is put forward in favor of pulverized fuel is that the boiler may be operated with it at widely different rates of steam production without any very great loss of economy. If we are to understand by this that a boiler using pulverized fuel may be run at a duty largely exceeding that for which it was designed, it is possible that the friends of fuel dust are a little too hopeful and will meet with disappointing experiences in this direction. At all events, the writer should like to see such views substantiated by more than one test before admitting their correctness.

It is true that the rapidity of combustion is limited in ordinary practice by the available chimney draft and other circumstances, and it is also true that a greatly increased rate of combustion is possible when using powdered fuel, especially with the air blast, because an enormous quantity of dust, thoroughly mixed with the correct quantity of air to ensure its perfect combustion, can be forced into the furnace. But on the other hand, it must be remembered that even when using ordinary coal in the usual way it is not necessarily the difficulty of securing perfect combustion that limits the economical performance of the boiler. The writer has seen boilers that could burn 27 pounds of coal per square foot of grate per hour, with entirely satisfactory results so far as perfection of combustion was concerned, when the most economical rate of combustion for these same boilers was only 17 pounds per hour. The difficulty was that the heating surface of the boilers was not sufficiently great to enable them to absorb so much heat; and while the heat was economically produced, altogether too much of it passed up the stack. So it does not follow because we can burn a much larger amount of fuel and attain ideal conditions of combustion, and can make the boiler give a greatly increased supply of steam, that we are thereby increasing its economy or even maintaining it undiminished.

It is true that the ability to run at a greater capacity is often a very valuable thing, even if the blast thereby temporarily loses in efficiency. Heavy loads for a short time are often thrown on the boilers of power stations in particular, and the ability to take care of them almost instantly is often of greater importance than the question of whether more coal is being used than is really necessary in order to do so. So the flexibility of the pulverized-fuel systems in this respect may be of great service, whether one has to sacrifice economy in availing himself of them, or not. It is true that boilers could be designed which would have greater heat-absorbing power, so as to be able to take care of a heat production much above the ordinary; but the writer imagines that for a considerable time to come the advocates of the use of pulverized fuel will find that the main problem before them is to adapt the system to the use of boilers that are already in existence, rather than to design and construct special types of boilers that will have much larger heat-absorbing capacity than is common to-day. And even if such special boilers were designed, it is highly probable that their owners would always operate them nearly up to their limit of economical performance, so that the margin left for contingencies would still be as small as at present. On the whole, the writer is not inclined to lay too much stress upon the value of the facility that powdered fuel offers for forcing boilers beyond their usual capacity. Its value will probably be found to lie chiefly in other directions.

PARALLEL OPERATION OF ALTERNATORS.

BY A. S. M'ALLISTER.

Electrically considered, the elements which affect the operation of synchronous motors apply as forcibly to alternators in parallel.

If, from any cause, the instantaneous e.m.f. of one machine is above that of the other, there will be a cross flow of current between the machines tending to equalize the e.m.fs. This cross current depends directly upon the relative difference of instantaneous e.m.f. of the two machines and inversely on the impedance of the circuit between them.

If the machines are excited to give exactly the same apparent e.m.f., are running at the same speed, and are in exact step, there may yet be a cross flow of current due to the difference in wave form of the e.m.fs. of the two machines. Under no circumstance can this cross current be absent if the alternators have different e.m.f. waves. Since any cross current is a source of loss it is evident that the best operation of alternators in parallel requires that their field poles and armature windings be so proportioned that their e.m.f. waves be similar and equal.

If one alternator be excited to give a higher e.m.f. than the other a current will flow between them which will tend to demagnetize the stronger field and strengthen the weaker one, so that the e.m.fs. generated by the two will be equal and approximately a mean of the two individual e.m.fs. The field excitation of alternators should, therefore, be adjusted to give them equal e.m.fs. when the cross current between them should disappear.

If, at a given instant, one alternator be ahead of the other in phase position, though they generate the same e.m.f. wave form and have equal excitation, there will be a cross flow of current tending to draw them into phase. This is the true synchronizing current. The difference in phase may be due to many causes, but in general, under operating conditions, it depends upon the prime movers.

If, when the alternators are returning to their normal co-phase position one or both receive an impulse tending to throw them out of phase in the other direction, they will pass the normal position and assume momentarily a position oppositely out of phase. A continuation and exaggeration of this phenomenon leads to hunting.

Alternators in parallel are held in step by a flexible coupling—the synchronizing current. The action of this current is quite similar to that of gravity on a pendulum. When the pendulum is swung to one side of the normal position, it is drawn back, and its momentum causes it to swing past the normal position. If, when the pendulum swings in one direction there is given it an impulse in the same direction, the amplitude of swing is increased. If, however, the impulse is in the opposite direction the amplitude is decreased. It is obvious that the amplitude of the swing depends not so much upon the value of the impulses the pendulum receives as the time-direction of such impulses.

With alternators, the swinging with reference to the normal instantaneous position is due to impulses received from the prime mover. These impulses come from the steam admissions, momentum of reciprocating parts, and the attendant irregular torque on the engine shaft.

Let us suppose, for illustration, that one alternator is momentarily ahead of the other in time-phase position. A current will flow in a direction to bring them into step. The strength of this current will depend upon the amount of phase displacement, and it will therefore be active up to the time the alternators reach exact step. But the armatures possess momentum, and unless some retarding force is brought to bear upon them they will pass the normal position and continue this relative motion till the force of the phasing current is sufficient to cause them to repeat the operation in the other direction. If the impulses which the armature receive during this oscillation are in a direction to retard the swinging, this relative motion will be lessened. If, however, the impulses are such as to assist this relative motion the amplitude of the oscillation will be increased. The periodicity of this oscillation of one alternator with reference to another is quite low; in general of about the magnitude of one cycle per second.

It should be borne in mind that this true hunting is quite independent of the irregular angular velocity of alternators driven by engines, though such irregular velocity is usually the prime cause of the beginning of the oscillation and furnishes the impulses for its exaggeration. Heavy fly-wheels, which assist in giving the alternators a regular angular velocity and thus lessen the liability to start hunting, cause them to have a tendency to continue in oscillation when once started.

The most satisfactory method of preventing hunting is by means of damping devices. These usually take the form of copper bars between or surrounding the poles. The current in the armature flows so as to make magnetic poles over the face of the armature. When regular running conditions are attained these poles occupy a constant position with reference to the field; that is, they have a velocity numerically equal and opposite to the relative motion between the alternator armature and the field magnet poles. Any change in the relative position of the armature poles and those of the field, due to hunting, etc., causes the damping bars to be cut by the shifting armature magnetism, and there flow in the bars currents which oppose the shifting of the magnetism. These devices, therefore, prevent a rapid change of phase position of the alternator armatures and have a steadying effect on the whole system.

When alternators are driven by engines having irregular angular velocity in each revolution, the damping devices will not prevent the alternators from having irregular velocity also. They will, however, prevent a very sudden change of relative phase position of the alternators. Thus, if two similar alternators be driven by similar engines, and be so connected that the irregular angular velocity is the same for both sets; that is, both the generators and engines are in step, the damping devices will have no effect whatever upon the irregularity in velocity. But if the alternators are in step and the engines are not, the damping device will tend to prevent a shifting forward and backward of one alternator with reference to the other.

The steadying effect of the damping devices is brought into play when the alternators shift relative positions. It is, therefore, greatest as the normal co-phase position is reached and passed, or when the velocity of change is greatest. The cross flow of phasing current between the alternators depends upon the relative phase displacement of the armatures, and is greatest when the machines are farthest out of phase. It is evident that alternators fitted with damping devices are subject to a retarding force or forces during the whole period of oscillation, whereas when the devices are absent the phasing current tends equally to decrease and increase the amplitude of oscillation.

For a given amount of phase displacement the value of the phasing current depends inversely upon the impedance of the circuit joining and including the armatures. If this impedance is extremely small the cross flow of current may be excessive. When alternators are designed for use with engines whose angular velocities vary considerably in each revolution, parallel operation dictates a fair amount of armature impedance; consequently, close regulation for such alternators is not possible.

Modern design has determined the maximum limit of phase displacement between two alternators to be about six degrees, which would, for the moment, cause to flow between the machines about 10.5 per cent of the short-circuit current. The amount of mechanical angular displacement allowable between the engine shafts during each revolution is not the phase displacement of the alternators, but is that displacement divided by the number of pairs of poles. Obviously, therefore, the less the number of poles the greater the allowable mechanical displacement, and with a given generator set revolving at a certain speed, the lower the frequency the smaller will be the phase displacement.

The foregoing discussion of the parallel operation of alternators has dwelt entirely upon the output side of the machines. It is advisable to consider also the equally important side of the subject—the energy supply. In order that alternators in parallel shall divide the load proportionately it is necessary that the prime movers have the same relative load-speed characteristic. If one alternator be driven by an engine whose governor regulates for constant speed at all loads, and another in parallel be supplied with energy by an engine with a drooping load-speed characteristic curve, the machines will divide the loads equally at one speed only, and no amount of field adjustment can correct for any difference in load division. A change of field strength merely alters the amount of cross current between the machines, while the voltage of each remains the same as that of the other.

For example, if two alternators be driven by engines each having a no-load speed of 100 r.p.m., and one of them is adjusted to deliver 500 horse-power at 99 r.p.m., while the other engine is adjusted to develop 1000 horse-power at 99 r.p.m., when 1500 horse-power is demanded they as a unit will run at 99 r.p.m. and divide the load in the ratio of 1 to 2 quite independent of all other conditions. It is plain, therefore, that when the prime movers have not exactly the same load-speed characteristic the best performance will, in general, be obtained when the characteristic of each is drooping, while perfect operation in parallel demands that both shall have the same speed at the same load throughout.

CURVES FOR SHOWING THE CHARGE REMAINING IN A STORAGE BATTERY.

Those who have charge of central-station storage batteries know that it is often necessary to tell on short notice what charge remains in a battery. If the capacity of the battery at different discharge rates is known, the amount of stored energy available in the battery can be calculated any time, provided it is known what discharge has already taken place. Such calculations take time, however, and it is usually essential, especially in emergencies, to know and advise the generating station at once as to how long a certain load can be carried. To enable this to be done, Ernest Lunn, who has charge of the storage-battery plant of the Edison Illuminating Company at Detroit, Mich., has made the accompanying set of curves. The heavy line curve, which cuts across the others at a slight angle, shows the capacity of the Detroit battery at different discharge rates, and was furnished by the manufacturers of the battery. From this curve the length of time during which any given current can be taken from a battery can be seen at a glance. Thus, following out the 1500-ampere discharge line to where it crosses the discharge curve, it is found that the point of crossing is at the 2½-hour line; this shows that the battery could discharge at the rate of 1500 amperes for 2½ hours before reaching its safe-capacity limit. In the same way the capacity at any other discharge rate can be determined.

A simple capacity curve of this kind is an important aid in the battery plant, but it is desirable to still further reduce the necessity for arithmetical calculation. The question that usually is put to the storage-battery attendant is how long the battery can carry a certain load. To enable this question to be answered quickly Mr. Lunn has plotted on the sheet a number of other curves corresponding to ampere-hour discharges of from 1000 to 5500 ampere-hours. These curves are equilateral hyperbolas; that is, the product of ordinate and abscissa is the same at any point of one of the curves. Suppose it is known that there have been 2500 ampere-hours taken out of the battery, and it is desired to know how long a certain discharge rate, say 2000 amperes, can be maintained. Follow up the 2500-ampere-hour discharge curve until it intersects the 2000-ampere rate line, and the horizontal distance from this intersection to the capacity curve, reduced to the scale at the bottom of the diagram, shows the length of time that 2000 amperes can be carried, which would be about 20 minutes in the case assumed. In a similar manner it can be ascertained how long any rate can be carried by the battery or whether it can be carried at all, if the ampere-hours previously taken out are known.

The principle on which the curves are based is simple. The ampere-hours at any point on any curve are represented by the area of the space enclosed by vertical and horizontal lines drawn from the point on the curve to the lower and to the left-hand edges of the diagram. The remaining charge in the battery at any time is represented by the difference between the area corresponding to the ampere-hours taken out and the area corresponding to the battery capacity at the proposed rate of discharge. It is not customary to work a battery near enough to the limit to make it necessary to consult the curves. It is, however, of the greatest advantage in emergencies to be able to tell at a glance how long a certain discharge rate can be maintained. The accuracy is, of course, dependent on how near the actual capacity of the battery in use corresponds to the capacity curve. Similar curves can easily be made for use with any battery if a reliable discharge-capacity curve for that particular type and size of battery is obtained from the makers or determined by test. The ampere-hour reference curves are simply the results of plotting a given number of ampere-hours at different rates of discharge.

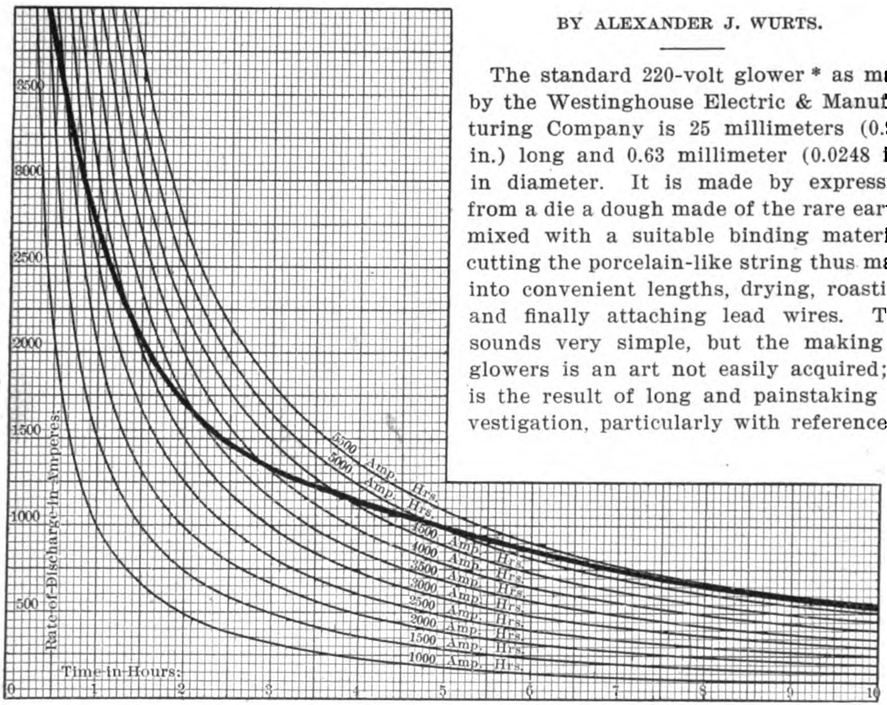


FIG. 1.—STORAGE BATTERY DISCHARGE CURVES.

DEVELOPMENT OF THE NERNST LAMP IN AMERICA.

BY ALEXANDER J. WURTS.

The standard 220-volt glower * as made by the Westinghouse Electric & Manufacturing Company is 25 millimeters (0.984 in.) long and 0.63 millimeter (0.0248 in.) in diameter. It is made by expressing from a die a dough made of the rare earths mixed with a suitable binding material, cutting the porcelain-like string thus made into convenient lengths, drying, roasting, and finally attaching lead wires. This sounds very simple, but the making of glowers is an art not easily acquired; it is the result of long and painstaking investigation, particularly with reference to the terminal connection between the glower and lead wire. This connection, as Dr. Nernst made it, consisted of a few turns of platinum wire wound around each end of the glower, the convolutions being finally pasted with cement. This forms a successful and effective terminal, but the shrinkage of the glower ends, away from the convolutions of platinum wire, sometimes causes the contact to deteriorate, resulting in the weakening and early destruction of the glower near the terminal. In the Hanks terminal these conditions are reversed. A platinum bead is embedded in the end of the glower in such a manner that any tendency to shrink on the part of the glower material can result only in tightening the contact and thereby maintaining intimate union between the platinum bead and the glower. It is, then, a simple matter to fuse lead wires to the embedded platinum beads.

The glower, as is well known, is a non-conductor when cold and becomes a conductor when heated. It is also an electrolyte; but it may be fairly stated that the electrolytic phenomenon is not clearly, if at all, understood. Oxygen, however, seems to be necessary or at least desirable for its successful operation. As might be expected, no electrolytic action is apparent when operating with alternating current. With direct current the electrolytic action is quite marked, resulting in a black deposit on the negative end of the glower which extends gradually from the negative toward the positive terminal. As this deposit increases, the voltage of the glower changes somewhat, and the candle-power and efficiency fall off, owing to the poor light-emitting properties of the blackened portion. The life of the glower on alternating current is about 800 hours; with the same glower on direct current, it is considerably less than this. There are, however, radical improvements being made in direct current glowers.

A glower burns at a higher efficiency in a globe than it does in the open air. I shall refer again to this feature in connection with the multiple glower lamp. The glower is about as strong as a piece of porcelain of the same size, and it is difficult to break a short section. The terminals of a glower give off platinum black, which deposits on the globe; and although this cannot be wiped off with a cloth, it is easily removed in a variety of ways, so that the globe may be considered a permanent fixture in the lamp, and, for that reason, may be given fancy designs. When properly made, the voltage of a glower changes but slightly during its life, the tendency being to rise from 2 to 4 per cent in 800 hours. For a short time before rupture, the voltage rises rapidly until the glower is broken.

The characteristic of a glower with reference to voltage and current is remarkable, and has given rise to the necessity of a steadying resistance. As the current in the glower is increased, the voltage across its terminals rises, at first rapidly, and then more and more slowly to a maximum, beyond which it again drops off with increasing rapidity as the current and resulting temperature through the glower continue to increase. Beyond the point of maximum voltage, the decrease in resistance of the glower is so rapid as to make the current difficult of control. In fact, without a steadying resistance, such a conductor would rapidly develop a short-circuit and flash out. The characteristic of a Nernst glower is shown in curve I, Fig. 1,

---

*Names of Parts in the Nernst Lamp.—The "glower" is the filament or light-giving body. The "ballast" is a steadying resistance connected in series with each glower. The "holder" is a removable piece containing glowers and heaters. The "heater-porcelain" is a porcelain disc in the holder immediately back of the heater. The "heater case" is a small glass globe used in the six-glower and thirty-glower lamps.

the small circle situated near the crest of the curve representing the point at which the consumption is 1.76 watts per candle in the open air.

In studying the characteristics of the glower and seeking for methods of operation under the best possible conditions, the behavior of the glower in various gases and in a vacuum was investigated, and although the experiments in this direction have not been exhaustive from a scientific standpoint, the results have been negative as far as practical results are concerned, and have demonstrated that for the present, at least, there is nothing to be gained in this direction. The vacuum curve and corresponding air curve are shown in Fig. 1. Aside from the fact that the vacuum has shifted the point of 1.76 watt efficiency to a much lower voltage and higher current density, it will be observed that all the points of the curve now lie on one side, giving a decreasing difference of potential for an increasing current. Such a condition as this involves the use of a relatively large steadying resistance, and renders the operation of the glower inefficient.

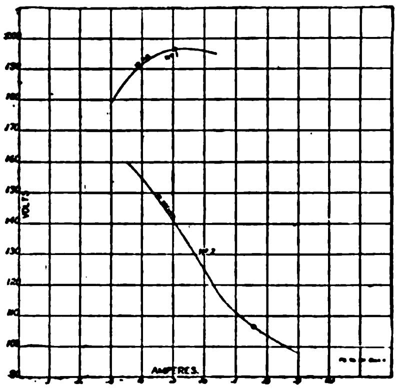


FIG. 1.—CHARACTERISTICS OF GLOWER IN VACUUM AND AIR.

Fig. 2 shows the nitrogen curve with corresponding air curve, and it will be observed, as in the case of the vacuum, that this gas has also rendered necessary a large steadying resistance and has thereby lowered the available efficiency of the glower. In Fig. 3, both the oxygen and hydrogen curves are compared with the air curve. It is interesting to note how nearly the oxygen and air curves agree with each other, while the hydrogen curve shows characteristics similar to that of the vacuum curve, requiring a large steadying resistance.

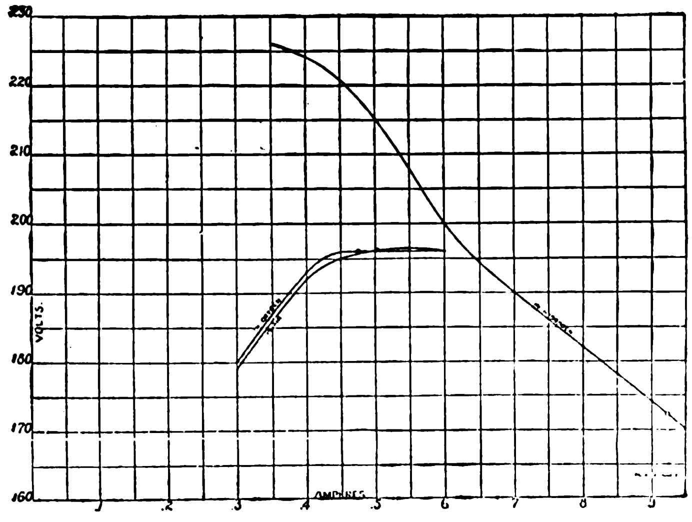


FIG. 3.—CHARACTERISTICS OF GLOWER IN OXYGEN, HYDROGEN AND AIR.

There is an interesting phenomenon connected with glowers operating in a space free from oxygen, and which seems to be especially pronounced when operating in a vacuum. Where oxygen is excluded, the glower seems to be sluggish and to respond but slowly to changes in line voltage. In air, the glower responds almost immediately to changes in the line voltage.

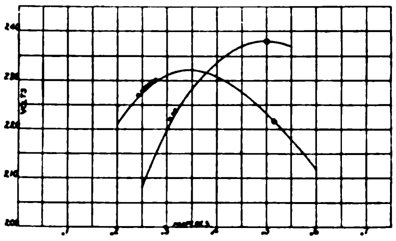


FIG. 2.—CHARACTERISTICS OF GLOWER IN NITROGEN AND AIR.

STEADYING RESISTANCE OR BALLAST.

The advantage to be gained by the use of a steadying resistance which would enable the glower to be operated efficiently at a point on or beyond the crest in the characteristic curve, has been well recognized. To accomplish this under all conditions of commercial use, and with as little loss as possible under normal conditions, the steadying resistance should have as large a positive temperature coefficient as possible and the temperature correction should always be immediately available.

Mr. H. C. Potter has designed a steadying resistance or "ballast," as he has named it, which meets very effectively the peculiar requirements of the glower. Iron wire is used on account of its high temperature coefficient, and by properly mounting this in a small glass tube filled with some inert gas, Mr. Potter has secured a ballast having at once a high corrective power with minimum resistance under normal conditions; and oxygen being entirely excluded, the wire can readily be worked throughout the entire high corrective region without danger of destruction. This remarkable characteristic of the ballast is well shown in Fig. 4, from which it will be noticed that for a 10 per cent rise in current, the resistance of the ballast increases 150 per cent, so that a glower thus protected becomes operative throughout a wide range.

THE HEATER.

For practical service in a lamp it is necessary that some means be provided for heating the glower and bringing it to a conducting temperature. The glower is lighted at a temperature of about 950° C. (1742° Fahr.) and it will be readily apparent that to acquire such a temperature quickly and without rapid destruction of the heater and adjacent parts, renders the selection of the materials a very serious problem.

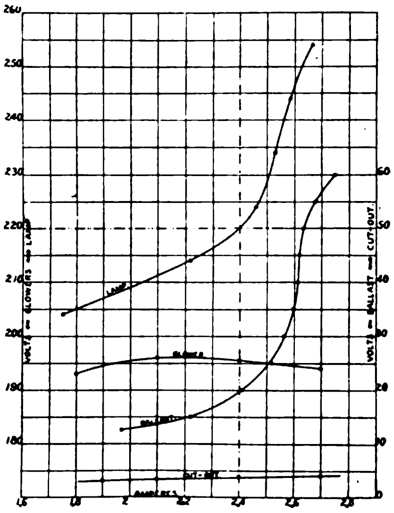


FIG. 4.—LAMP CURVES.

Platinum for the heater seems an undesirable expense in a commercial lamp, but although many attempts have been made to devise a cheap mineral heater, platinum still holds its own as the least expensive, the most durable, and altogether the most desirable material for this purpose. The actual expense, however, is not so serious, because when the platinum heater is burned out, the value of the scrap is nearly 90 per cent of the original cost, and as the labor required to work it is almost negligible, the running cost of the heater is small. As now constructed, the heater consists of a thin porcelain tube overwound with a fine platinum wire pasted with cement, the latter serving as a protection to the platinum wire from the intense heat of the glowers. These tubes are wound for 110 volts and are connected to pairs of two in series, according to the service, the one, two, and three glower lamps taking one pair, and the six-glower two pairs.

The heater tubes are mounted on a porcelain support in such a manner as to afford easy access for repair without removing the glowers. The life of the heater when running continuously is about 200 hours, and 133 hours when the current is turned on and off 4,000 times at regular intervals. Inasmuch as the heater is not

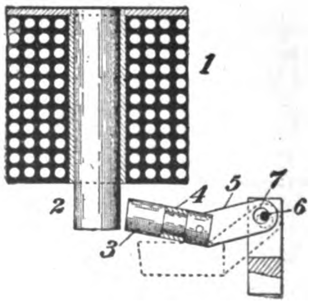


FIG. 5.—HEATER CUT OUT.

called into service for more than about 30 seconds to light the glowers, this would indicate a practically infinite life. In actual service, however, the heater remains in close proximity to the glowers and the high temperature to which it is thereby subjected causes a material decrease in its life.

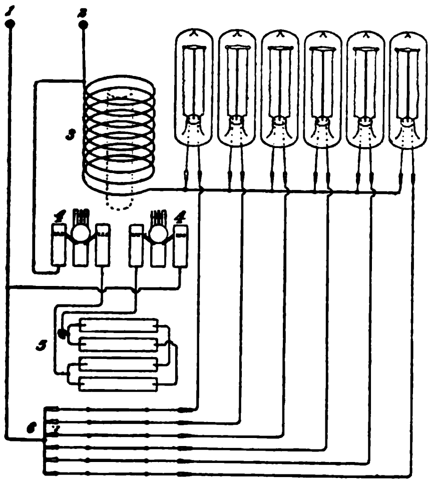


FIG. 6.—DIAGRAM OF CONNECTIONS.

CUT-OUTS.

An automatic lamp requires a cut-out to disconnect the heater from the circuit as soon as the glower shall be lighted. This is another one of those details that Dr. Nernst developed and exhibited in some of his early lamps, but which we have sought to still further perfect and to adapt to the special types of lamp which we have constructed. The cut-out includes a coil, a moving member and a contact, all of which must discharge their functions at a temperature of about 110° C. (230° Fahr.) without possibility of failure. The coil must therefore be heat proof, the contact must not weld, and the moving member should not hum on alternating current. These requirements are severe, but they have all been met by embedding the coil in cement, by making the contact of silver, and by suspending the moving member from a single point of support.

The latter feature of the cut-out is illustrated in Fig. 5; 1 is the coil; 2 the core; 3 the armature or moving member, which is round in section; 4 is a silver band which makes contact by gravity with two silver wires not shown, forming a V; 5 is a strip of sheet steel .007 in. thick, which is inserted into the armature and securely held by a pin; 6 is a small steel rod or support for the armature; and 7 is a hole in the steel strip 5, somewhat larger in diameter than the pin 6, so that when the armature is attracted by the magnet there is practically only a single point of contact between the strip 5 and the supporting pin 6. This construction has resulted in a cut-out which entirely avoids the humming sound so persistent in the ordinary types of alternating current apparatus.

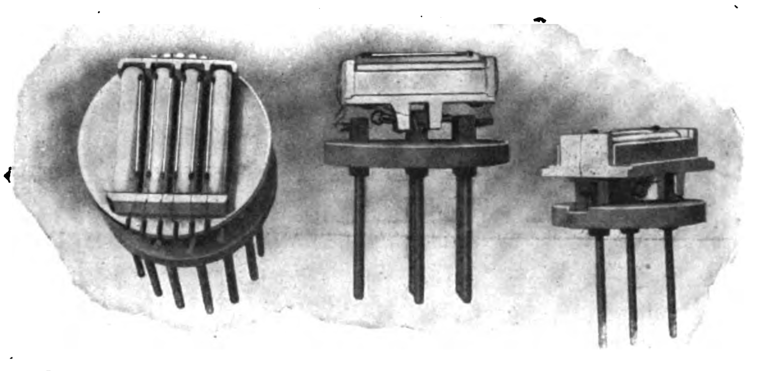


FIG. 7.—HOLDERS FOR THE SIX, TWO AND THREE, AND ONE GLOWER LAMPS, SHOWING AN ALUMINUM PLUG READY TO BE INSERTED.

COMMERCIAL LAMPS.

The lamps thus far developed are as follows:

Candle-Power.	Voltage.	No. of Glowers.	Style.
50	110	1	Indoor and outdoor.
50	220	1	Indoor and outdoor.
100	220	2	Indoor.
170	220	3	Indoor.
400	220	6	Indoor and outdoor.
2000	220	30	Indoor.

The main features are the same in all. Single glower lamps have single pole cut-outs, whereas all the multiple glower lamps are provided with double pole cut-outs, the reason for this difference being that the extremely high temperature in the immediate neighborhood of a number of glowers tends to establish leakage currents between the glowers and heaters, unless the latter be entirely disconnected from the circuit.

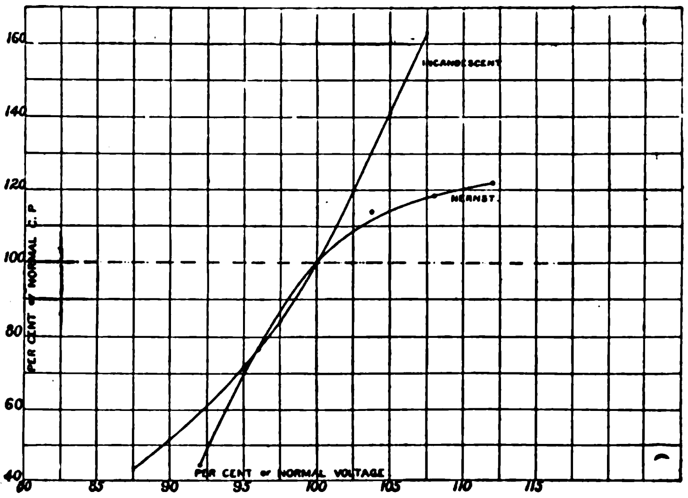


FIG. 8.—CANDLE-POWER CHARACTERISTICS.

We will examine in detail the six-glower lamp as typical of all the others. This lamp is suspended from an eye-bolt, the removal of which gives access to the inner parts by allowing the housing to be removed. The ballasts are placed in a semicircle around the cut-out, the arrangements of the parts being such as to make all easy of access. The connections are made with small aluminum plugs on the ends of the interconnecting wires which avoid the many familiar inconveniences associated with set screws. All the parts are mounted on porcelain; in fact, there is no combustible material whatever in the lamp. The heaters and glowers are attached to a removable piece or "holder," the design being such that the heaters backed by a porcelain disk are immediately above the glowers, resulting in the following advantages: Stagnation of heat from the heater, thereby lighting the glowers in minimum time; no shadows, nearly all the light being thrown downward where it is ordinarily most desired; stagnation of heat from the glowers whereby the latter are run in their own heat and therefore at a higher efficiency than they would otherwise.

The glowers and heaters are attached to the binding posts of the holder by means of small aluminum plugs, so that the perishable members are always easily and conveniently interchangeable. The holder is provided with nine contact prongs, which, when the holder is pushed up into the lamp, automatically make the desired connections. These are shown in Fig. 7. Fig. 6 is a diagram of connections and parts, in which 1 and 2 represent the line terminals; 3 the actuating coil; 4 and 4 the double pole cut-out; 5 the heater; 6 the glowers; and 7 the ballasts, there being, of course, one ballast for each glower. A small glass globe, called the "heater-case," is held by spring clamps around the glowers, the function of which is to retain the heat and thereby decrease the time of lighting as well as increase the efficiency of the glowers. In service, the "heater porcelain," which is the porcelain disk immediately above the heater, becomes coated with a thin layer of platinum black, unless measures are taken to prevent it, and this not only decreases the illuminating power of the lamp, but if not removed, will in course of time become conducting and cause leakage of current.

No simple means have been discovered for removing the platinum black from the porcelain surface, but this difficulty has been avoided by coating the surface of the porcelain with a thin layer of white paste, which may be easily removed with a stiff brush or scraper. The platinum black deposits on this coating, both of which may be removed together, leaving the fresh, white surface of the original porcelain to be recoated for further service. Even should the platinum black be allowed to accumulate, all danger of leakage currents is avoided by encircling the holes through which the lead wires pass with small annular rings or grooves, it having been discovered that the platinum black will not deposit in these small spaces; the continuity of the platinum black surface between the lead wires is thereby interrupted. For higher candle-powers, the six-glower holder is used as a unit and this may be multiplied to any desired limit.

EFFICIENCY.

It is not an easy matter to state the efficiency of a light, and the difficulties are especially pronounced in the case of the Nernst lamp. It would seem desirable, therefore, to give the results of various methods of measurement and comparison, rather than to make any definite statement based on any particular method or set of readings. Referring, therefore, to the six-glower, 220-volt, alternating-current lamp, from which most of the data has been obtained, we may note the following:

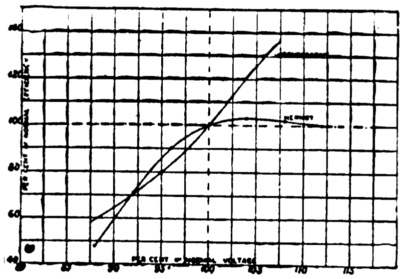


FIG. 9.—VOLTAGE-EFFICIENCY CHARACTERISTICS.

A 220-volt glower operating at its normal current of 0.4 ampere, requires 20 volts more in the open air than when burning with five other glowers in a 3-in. globe. The lower voltage and consequently the improved efficiency, when multiple glowers are placed in a globe, is due to the fact that the glowers are operating in a highly heated atmosphere. The efficiency of the six-glower lamp with clear heater case, but without the dome shade, is 1.2 watts per Hefner unit (1.35 watts per candle) measured in the direction of greatest intensity.

The accompanying table gives the spherical and lower hemispherical efficiencies of a six-glower Nernst lamp, together with the corresponding figures for alternating-current and direct-current enclosed arc lamps:

					Mean Intensity in H. U.†						Watts per Mean H. U.‡					
					Spherical.			Lower Hemisphere.			Spherical.			Lower Hemisphere.		
	Voltage.	Current.	Watts.	Power factor.	Opal Outer.	Clear Outer.	Shade.	Opal Outer.	Clear Outer.	Shade.	Opal Outer.	Clear Outer.	Shade.	Opal Outer.	Clear Outer.	Shade.
6-glower..	220	2.35	517	1.0	149*	...	147	240*	...	279	3.47*	....	3.5•	2.15*	....	1.85
A. C. Arc	110	6.29	417	.6	130	159	152	...	190	254	3.21	2.62	2.49	....	2.23	1.48
D. C. Arc	110	4.9	539	1.0	177	207	...	...	272	...	3.03	2.60	....	....	1.98	....

An opal inner globe or heater-case was used in all cases except the four readings marked *.

†To reduce to candle-power multiply by 0.885.

‡To reduce to watts per c. p., multiply by 1.13.

•A clear heater-case and sandblasted spherical globe were used.

The arc lamp figures were taken from the Report of the Committee for Investigating the Photometric Values of Arc Lamps, read before the National Electric Light Association in May, 1900. It will be noticed that the spherical efficiency of both arc lamps is better than that of the Nernst. In the lower hemisphere, the Nernst is somewhat better than the alternating-current arc and not as efficient as the direct-current arc. When reflecting shades are used, the alternating-current arc again has a slight advantage for the whole of the lower hemisphere; but if we disregard the mean of the lower hemisphere and consider the floor or desk illuminating power of the lamp, the Nernst lamp has a very decided advantage over the enclosed alternating-current arc. For example, considering the mean of the lowest 30° zone, the efficiency of the enclosed alternating-current arc is 1.56 watts against one watt for the Nernst and the mean of the lowest 60° zone is for the enclosed alternating-current arc 1.45 watts against 1.23 watts for the Nernst.

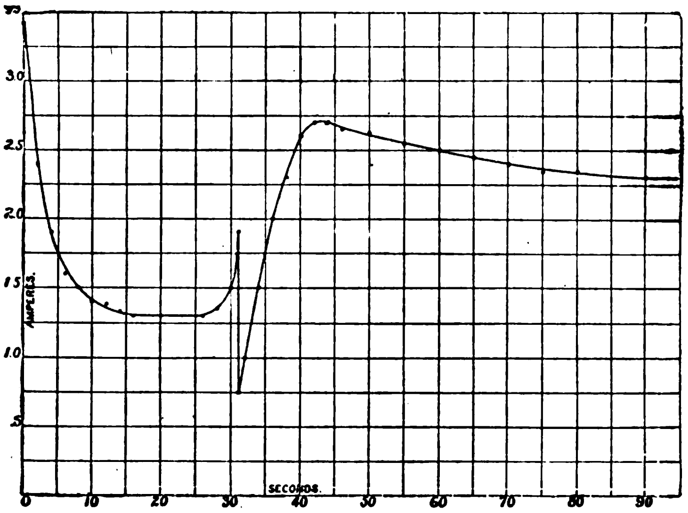


FIG. 10.—CURVE SHOWING CURRENT TAKEN DURING STARTING PERIOD.

Comparisons between the illuminating powers of the Nernst and incandescent lamps indicate a watt consumption in the Nernst lamp a little less than half of that in the incandescent for equal illumination. The superior quality of the Nernst lamp is also very marked both for reading purposes and for the correct determination of color.

The two sets of curves, Figs. 8 and 9, show interesting comparisons between the Nernst and incandescent lamps under conditions of varying voltage. Fig. 8 shows the relative change in candle-power and Fig. 9 the relative change in efficiency, all the variations in each case being given in per cent of normal conditions. These curves are self-explanatory except as to the remarkable steadiness of candle-power in the Nernst lamp when forced above normal voltage. The feature is due to the great corrective power of the iron ballast resistance.

At present data regarding the effect of running Nernst lamps at different efficiences are rather limited, but roughly, it may be stated that the efficiency of the glowers falls but slightly during their natural life, provided the lamps are kept properly cleaned.

PERFORMANCE OF THE LAMP.

At the present writing (July 15) there are in operation at East Pittsburg 73 six-glower lamps, one three-glower and three single-glower; at Allegheny, 40 six-glower, 10 three-glower, 21 single glower, four out-door six-glower, and one out-door six-glower lamp indoors, all running on alternating current at 220 volts. In addition to these, there are 14 single glower direct current 110-volt lamps in Mr. Westinghouse's residence, making a total of something like 50,000 candle-power in Nernst lamps in and about Pittsburg.

Seventeen six-glower lamps have been running at East Pittsburg for more than a year, and are now showing an average life of 800 hours per glower. A similar record has been made with 14 six-glower lamps operating in Allegheny for about a year and a half. The four out-door six-glower lamps have been running every night during the last twelve months through all kinds of weather, and up to the present time have not given a moment's trouble. The six-glower lamp used indoors is in the tumbling room of the Westinghouse foundry, and it failed in the cut-out at the end of 1000 hours owing to the accumulation of a bunch of iron dust on the pole of the cut-out magnet, but a few strokes of a brush removed the difficulty and the lamp was continued in service. The line service to these lamps has been fairly good for a shop circuit. As a matter of record, however, it was decided to test four six-glower lamps on a circuit having wide voltage fluctuations and to keep a record of the service and the lamp performance. The record follows:

Four six-glower, 220-volt lamps were run 1000 hours. The run was continuous with the exception of three periods per day of one-half hour each, when the lamps were turned off. A record of the voltage was kept with a Bristol recording voltmeter. An inspection of the voltmeter cards shows that these may be divided into three classes. Of the first, there were 15 cards indicating that the voltage did not rise higher than 229 volts and only remained there for a short period. Of the second class, there were 26 cards showing a maximum of 232 volts, which was maintained for about four hours. Of the third class, there were four cards showing a rise of voltage to 237 and a sustained voltage of 235, which was maintained for five hours. These cards show that the lamps have been tested on a circuit the voltage of which varies from 4 per cent below to 7½ per cent above normal. There were no ballasts or heaters burned out during this run, nor did the lamps receive any attention or give any trouble.

Of the 24 glowers in these lamps, 15 ran 1000 hours, 6 ran 792 hours, 1 ran 580 hours, and 2 ran 380 hours, making an average of 890 hours.

The three, two and one-glower 220-volt, alternating current lamps have given equally satisfactory service, but the glowers in the 110-volt alternating current lamp are not quite so uniform in their performance and the same glowers on direct current are comparatively short-lived, averaging in the neighborhood of 150 hours; 220-volt glowers, however, on a direct-current circuit would last nearly double that time.

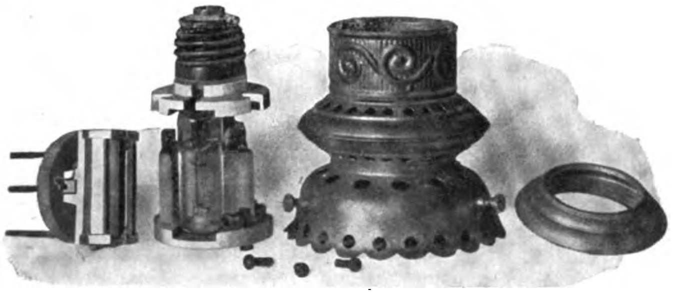


FIG. 11.—PARTS OF THE SINGLE GLOWER LAMP.

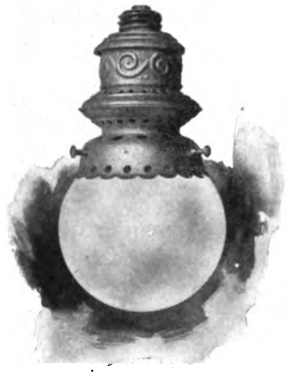


FIG. 12.—SINGLE GLOWER LAMP.

It will be interesting to note just what goes on in the lamp during the time of lighting, also during service under varying conditions of line voltage. In Fig. 10 is shown a curve showing the current taken by a six-glower 220-volt lamp during the lighting period. It will be noticed that as the current is turned on there is a sudden rush of nearly 3.5 amperes through the heater, which, owing to the temperature correction of the platinum wire, is quickly reduced to about 1.3 amperes. At the end of 26 seconds, the first glower begins to light; at the end of 30 seconds, the second glower is lighted and the heater is cut out, the current dropping at once to ¾ ampere; the remaining glowers then light rapidly until at the end of 40 seconds all the glowers are lighted. From this point on, there is a slight drop in the current until the lamp reaches its normal running temperature.

Referring back to Fig. 4, we find the current and voltage characteristics of the different elements in the lamp, and above these the characteristics of the lamp itself, which should correspond to the summation of the characteristics of the individual elements. The lamp curve was taken from actual measurements and approximates very closely to the sum of the element characteristics, the slight difference probably being due to some differences of temperature. The voltage scale for the cut-out and ballast curves will be found on the right-hand side of the diagram; that of the glower and lamp on the left-hand side. Attention is directed to the excellent characteristic of this lamp. With a normal current in the lamp of 2.4 amperes at 220 volts, it will be noticed that an increase of 14 per cent in voltage causes but a 10 per cent increase in current, resulting in a comparatively steady light and safe running conditions for the lamp in commercial service. A rise of 25 per cent in the line voltage would burn out the ballasts in a very short time, but a rise of 10 per cent for short periods does not seriously affect the life of either glower or ballast; a rise of 5 per cent may be considered allowable for indefinite periods.

REPAIR AND MAINTENANCE.

When the lamps are first started, they require no attention. After 1000 hours, however, the renewals become fairly regular and our experience thus far shows an average life of 800 hours for the glowers, 2000 to 3000 hours for the heaters and an indefinitely long life for the ballasts. It will, however, be some time before the average life of the heaters and ballasts can be definitely determined. The attention which these lamps receive consists in having the inspector examine the lamps once a week through a colored glass to determine whether or not all six glowers are burning. If two glowers are out, new glowers are inserted in their places and the lamps continued in service. Aside from such renewals, these lamps have not given the least trouble.

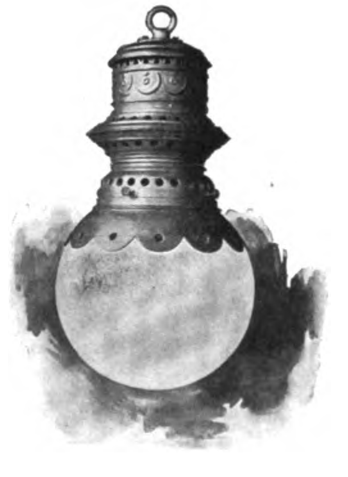


FIG. 13.—TWO AND THREE GLOWER LAMP. INDOOR TYPE.

On the occasion of starting up 50 six-glower lamps at East Pittsburg, one of the engineers who had had considerable experience with arc lamps remarked that my troubles would now begin; but I think he was mistaken. Aside from the renewal of the perishable parts, I see nothing in the lamp which could possibly cause trouble except under the most extraordinary circumstances. In fact, should a lamp receiving proper attention fail to light, I would look for the trouble elsewhere than in the lamp.

In commercial service it is intended that the central station shall make the renewals in the holders. The customer will be provided with a case containing a suitable number of complete holders, ready for service, so that when a renewal is to be made, the customer will simply remove the old holder and insert a new one, such operation consuming but a moment's time; then, at convenient periods, the old holders will be exchanged for new.

Where lamps are used in quantity, the renewals will probably be made by the local attendant. The replacing of a ballast requires the removal of the lamp from the circuit, but after that the renewal is easily and quickly made. A slight withdrawal of one screw releases the ballast tube from its socket, whereupon the small aluminum terminal plugs may be withdrawn and the new ballast inserted. This operation does not require any tools other than a pair of small tweezers, and the renewal can be made without returning the lamp to the workbench. After about 100 lamp-hours the heater case becomes somewhat discolored, and, for first-class maintenance, this should be cleaned at the end of that time.

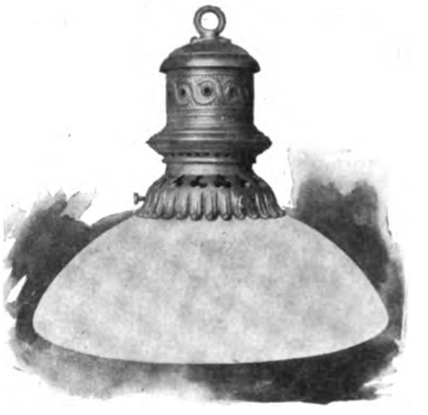


FIG. 14.—SIX GLOWER LAMP.

COST.

It is too early to say anything definite about the cost of these lamps. Fourteen or fifteen dollars would seem to be a fair price for a six-glower lamp, others lamps in about the proportion of the number of glowers. It is estimated that the cost of renewals will be considerably less than for enclosed-arc lamps. Provision will be made for the return of the perishable parts containing platinum.

[The foregoing is an abstract of a paper read at the Buffalo meeting of the American Institute of Electrical Engineers, August 23, 1901.]

Abstracts from Foreign Contemporaries

Device for Dimming Incandescent Lamps.—The "Elektrotechnische Zeitschrift" contains an article by P. Stern on a cheap device for dimming incandescent lamps. The dimming is performed as shown by Fig. 1, which is simply a device for connecting another lamp in series with the main lamp; the voltage and candle-power of this auxiliary lamp being so chosen that it burns at normal voltage when in series with the main lamp. He shows also how to calculate the best type of auxiliary lamp for this purpose.

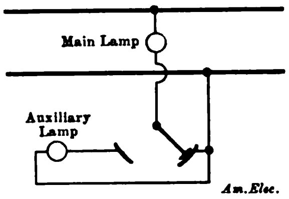


FIG. 1.—DIAGRAM OF CONNECTIONS.

peed Regulation of Shunt-Wound Motors.—This is the subject of an illustrated article appearing in a recent issue of the "Elektrotechnischer Anzeiger" over the signature of Oswald Stock. The article treats of the speed regulation within wide limits, of shunt-wound motors used for driving machines in paper mills, dyeing plants, etc., where speed variations of 30 to 1 and 60 to 1 are oftentimes required. As shown by Fig. 2, the motor has a rheostat in its shunt field circuit and is supplied with current from a special dynamo, which is excited by a small compound-wound dynamo whose shunt field is also provided with a rheostat. Where exigency requires two motors which are to work independently, the author uses two primary dynamos, which are excited by the same compound-wound exciter. A rheostat is provided in each of the fields of each primary dynamo. This will be readily recognized as a modification of the Ward Leonard system.

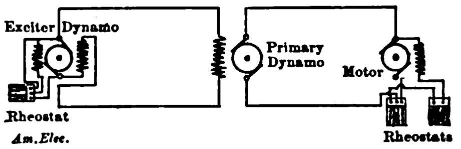


FIG. 2.—DIAGRAM OF CONNECTIONS.

Measuring Speed Variation—Fig. 3 taken from the London "Electrical Review," shows a simple method, devised and used, it is said, with good success by the engineers of the General Electric Company, for measuring the speed variation of an engine. A bicycle wheel, *C*, is direct connected to a ½-kw. bipolar dynamo, *G*, and mounted so that the tire presses against the fly-wheel of the engine, *F*. The field of the bipolar dynamo is excited by a storage battery, S_1, and the armature is connected in opposition to another storage battery, S_2. Between the two is a Weston direct-current voltmeter, *M*, with a low reading scale. When V is adjusted so as to equal V^1 any variation of V will be indicated by the voltmeter; and, as the value of V is proportional to the speed of the engine any variation of angular velocity will be shown by the voltmeter. The method being differential in its action is very sensitive, and the degree of accuracy may be enhanced by either using a still lower reading voltmeter or raising the voltage of the dynamo.

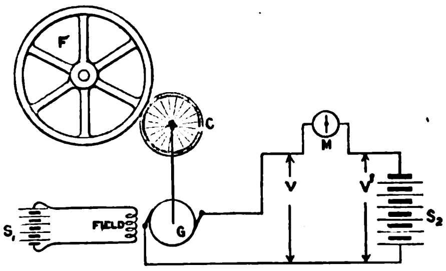


FIG. 3.—MEASURING SPEED VARIATION.

Storage Batteries Controlled by Reversible Boosters.—J. S. Highfield recently read an interesting paper before the British Institute of Electrical Engineers on "Storage Batteries in Electric Power Stations controlled by Reversible Boosters." The author rejects the regulating cell system and advocates regulation by means of a variable pressure booster, which is so designed that by varying the field, the voltage can be varied from zero to a maximum either way. Fig. 4 is a diagram of the arrangement. The booster has a double-wound armature in one field, each half of the battery being in series with one of the armature windings. The field is varied by a 30-point rheostat, interlocked with which is a reversing switch. The voltage given by each armature may be varied from zero to 50, each step of resistance serving to effect a variation of a trifle less than 2 volts. The battery center is connected to the neutral bus-bar of a three-wire system and a good type of balancer is employed. One half of the battery may be charged by disconnecting the other half from the bus-bars, and charging through the balancer. The battery serves to steady the station voltage and relieve the generators of fluctuations, and also acts as a reserve.

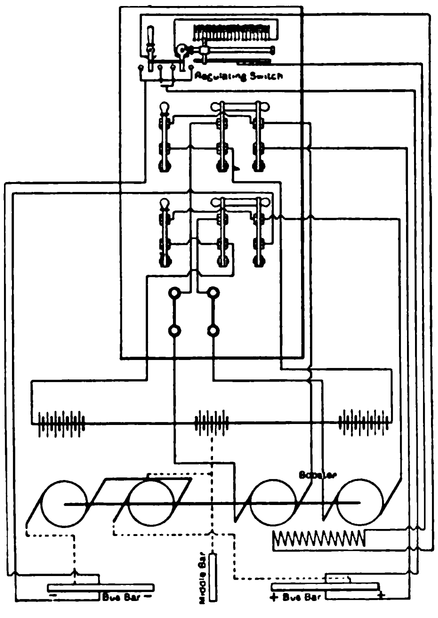


FIG. 4.—DIAGRAM OF CONNECTIONS.

Preventing No-Load Losses in Transformers—An illustrated description of a device which obviates the no-load losses in a transformer by switching out the primary when the secondary circuit is broken, appeared in a recent issue of the "Elektrotechnische Zeitschrift." The arrangement is shown diagrammatically by Fig. 5, where *S* represents a solenoid arranged to actuate the primary switch, *A* and *s* is a small electromagnet controlling at *b* a circuit which includes its own coil and the battery *B*. The coils of both magnets are supplied with current only at the moment of the opening or closing of the circuit; *S* receiving current from the secondary of the transformer *T*, and *s* receiving current from the battery *B*. When throwing the motor, *M*, out of circuit, the secondary switch, *a*, in passing to the off position shown in the engraving, strikes the contact, *k*; the solenoid, *S*, is immediately energized, lifting its plunger and throwing the primary switch, *A*, out of contact. The plunger is held up by the arm, *l*, attached to the armature of the magnet, *s*. To throw in the motor, the secondary switch, *a*, is closed, whereupon the magnet, *s*, is energized, attracting its armature and removing the arm, *l*, from the path of the solenoid plunger, thereby allowing the latter to drop and close the primary circuit.

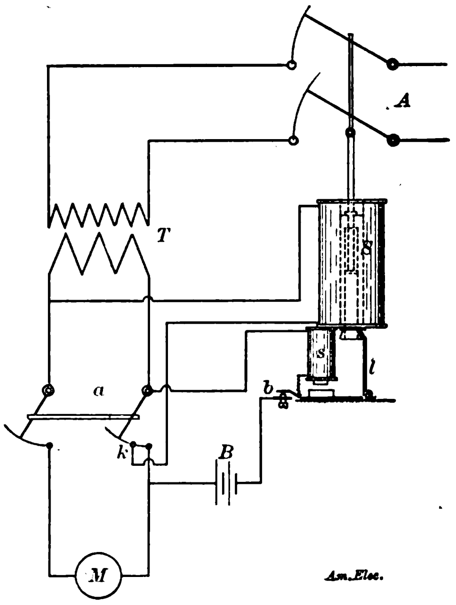


FIG. 5.—PREVENTING NO-LOAD LOSSES.

Instrument for Measuring the Permeability of Iron and Steel.—A permeability meter, which has for its principle the balancing of the reluctance of an air-gap against that of the specimen under test, by means of altering the length of the air-gap, is described in a recent issue of the London "Electrician." Fig. 7 shows a longitudinal section of the instrument. The specimen to be tested consists of a bar, *A*, turned up to a definite diameter. One end of this fits into an iron head, *B*, any looseness in the fit being taken up by the screw, *S*. Surrounding the specimen is a magnetizing coil, *F*, and the head, *B*, fits into a recess turned in another magnetizing coil, *E*, encircling the adjustable air-gap. The other end of the specimen is fixed to the yoke-piece, *G*, by the block, *J*, and two set screws. Opposite the end of the head, *B*, is the flat face of an iron cylinder, *C*. This slides freely, but with a good fit, through a hole in the yoke, *G*, and can be moved parallel to its own axis by a screw, *D*, turned by the handle, *H*. This enables the operator very gradually to alter the length of the air-gap between *B* and the cylinder *C*. The number of turns and fractions of a turn made by the screw are read on the scale and graduated head shown in the figure. When testing, the coils, *E* and *F*, being properly connected, are put in series with a reversing key, an adjustable resistance, an ammeter, and a few accumulator cells. For the purpose of more finely adjusting the current the apparatus is preferably connected up as shown in Fig. 6. The ammeter is provided with a second scale from which the magnetizing force applied to the specimen can be directly read. The reading of the air-gap scale is taken, and the calibration curves supplied with the instrument give the permeability or its reciprocal without any calculation. The authors, C. G. Lamb and Miles Walker, do not claim that the instrument is as minutely accurate as Professor Ewing's, but they claim it is simpler and more convenient in operation.

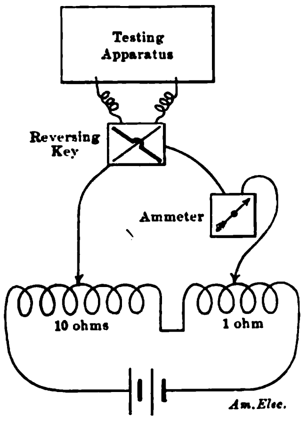


FIG. 6.—DIAGRAM OF CONNECTIONS.

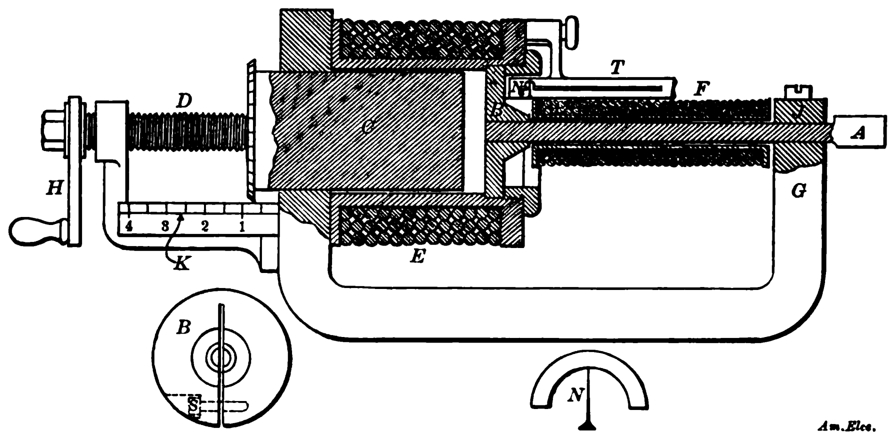


FIG. 7.—INSTRUMENT FOR MEASURING THE PERMEABILITY OF IRON AND STEEL

The Schmidt System of Superheating.—Prominent among the various systems of superheating that have been tried, both on the score of simplicity and efficiency, is that based on the Schmidt patents. The London "Mechanical Engineer" describes in a recent issue this system, which is a combination of two distinct methods known as the concurrent and counter-current systems, according as the heating gases and steam travel in the same or opposite directions. The counter-current system, while giving extremely good results, is open to the objection that the hottest gases meet the superheating tubes at the part where the steam is hottest, resulting in burnt tubes; while the concurrent system, devised to avoid this drawback, does not secure the maximum difference in temperature between the steam in the tubes and the outside gases. The Schmidt system, being a combination of these two, ameliorates as far as possible their relative drawbacks. Fig. 8 shows the general arrangement of a direct-fired superheater. Saturated steam entering at the top through the valve, *C*, is dried in the upper half of the coils, *B*, and passes thence through *D D* to the bottom tube *A*, whence it flows on the concurrent system in the same direction as the flue gases, taking up heat from them on the way, and leaving the superheater when it is hottest. The gases leave the superheating coils, *A*, at about 1000° Fahr., and after leaving the drying coils, *B*, enter the main flue at a temperature of about 460° Fahr. The superheater consists of a number of coils of equal size, the ends of which are fixed to cast-iron junction boxes. These boxes are placed outside the chamber, thus avoiding contact with the flue gases, and are easily accessible even when the superheater is at work. Each coil can be taken out and replaced without removing the others or dismantling the plant. The water of condensation collects in the bottom junction box and escapes through the drain-cock, *H*. A steel mercury thermometer, having a red mark to indicate maximum temperature, is placed where the superheated steam enters the main steam pipe; an electric alarm sounds when this mark is passed. A pocket is also provided for a glass thermometer which acts as a check on the steel mercury thermometer.

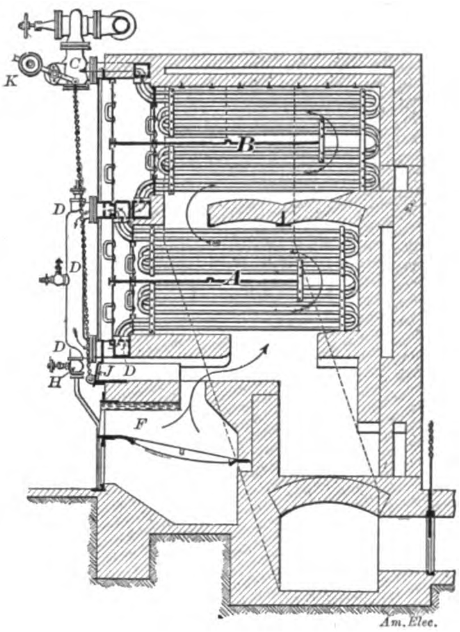


FIG 8.—SCHMIDT SYSTEM OF SUPERHEATING.

Phosphoric Acid Accumulator.—W. Hibbert describes in a recent issue of the London "Electrical Review" a novel cell designed by Pascal Marino. It is a lead accumulator having the usual peroxide and spongy lead as the active materials; but the plates are arranged horizontally, and the acid is not sulphuric, but phosphoric. Fig. 9 is a sectional representation of the general arrangement. Each plate consists of a thin sheet of lead, flanked by an ebonite frame. Within this frame and in active contact with the lead plate, is disposed the active material. Between each plate is a very porous separator, and running vertically through the plates are one or more carbon chimneys to carry off the gases. For the purpose of forming the active substances from the original material, sulphuric acid is employed; but as soon as the formation is complete, the sulphuric acid is taken out and phosphoric acid is substituted. The ordinary processes of charge and discharge are after-

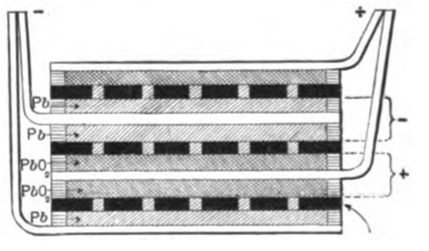
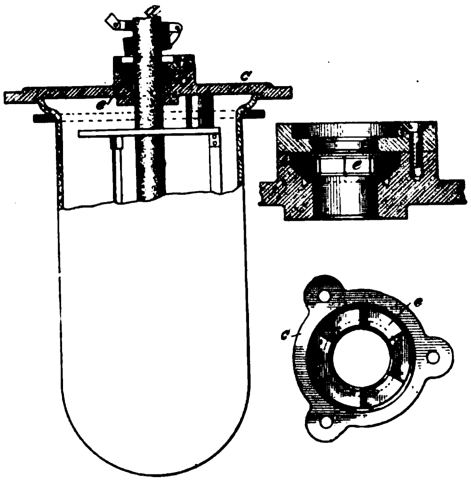


FIG. 9—PHOSPHORIC ACID CELL.

ward carried on in phosphoric acid; but after each charge a few drops of a solution of hypophosphorous acid are added for the purpose of destroying any peroxides that may be formed in the liquid. Many advantages are claimed for the cell over the ordinary sulphuric acid accumulator

Some Recent Electrical Patents

Gas Check for Enclosed Arc Lamps.—In lamps of the enclosed-arc type some trouble is experienced in restricting the access of air to the inner globe, and at the same time in affording ample opportunity for the gases formed within the globe to escape. The upper carbon usually enters the inner globe or envelope through a hole in the plate at the top of the envelope, and it is obvious that the hole in the plate cannot be made to fit, with the same degree of approximation, different carbons of the same nominal diameter or even all parts of a single carbon, on account of the unavoidable variation in the diameter of the carbon sticks. Therefore the hole in the upper plate is made large enough to insure the entrance of a carbon a trifle larger than the nominal diameter, with the result that when carbons are obtained which are a trifle smaller than the nominal diameter the entrance of air to the arc chamber is freer than desired, and the carbons are consumed at an uneconomical rate. Figs. 1, 2 and 3 herewith, illustrate a device which has been patented by Ernest P. Warner for the purpose of meeting this difficulty. The hole in the center of the plate, *c*, through which the carbon, *d*, enters the arc chamber, is provided with a segmental bushing or packing ring, *e*. This ring is turned out in one piece, the inner diameter being made that of the smallest carbon which is likely to be used in the lamp, and the ring is then cut into segments by a very thin saw. The upper part of the ring is flat, but the under surface is beveled to fit the sloping walls of an annular groove in the plate, *c*, and concentric with the carbon. It is evident that the weight of the packing ring and the outer slope of the V-shaped groove tend to close the packing ring about the carbon, leaving only the slits between the segments of the ring for the entrance of air. With a carbon of minimum size the slits between the segments of the packing ring are not quite closed. With a carbon of slightly larger diameter the segments of the packing ring are pushed out further from the center and the slits between them are larger; this is compensated for, however, by the fact that the larger carbon leaves less annular space between it and the hole through the plate, *c*. It is evidently a mere matter of calculation to so proportion the various parts that the opening into the arc chamber will be practically the same for all positions of the packing-ring segments. Fig. 2 is an enlarged transverse section of the ring and its seat, and Fig. 3 is a plan view of the same. Patent No. 678,446.



FIGS. 1, 2 AND 3.

Electric Elevator Controller (Brake).—When an elevator car is over counterweighted it is usually impracticable to predetermine whether or not the car and its load will tend to aid the momentum of the driving machinery after the current has been cut off, or the contrary. When the elevator is rising, if the counterweight be heavier than the elevator and its load, it is obvious that more braking power will be required to bring the magnetism to a stop than if the reverse were the case. In order to provide for opposing the momentum of the heavier of the two bodies—the car and its load or the counterweight—in proportion as the tendency to speed up increases, N. O. Lindstrom has devised and patented the arrangement diagrammatically illustrated by Fig. 4. This consists of a solenoid, the winding of which is included in a circuit that is automatically connected by the operating lever to the brushes of the driving motor when the current is cut off. In series with the solenoid is a rheostat, the various sections of which are arranged to be cut out by traveling fingers drawn over contact buttons by the core of the solenoid. It is evident that the higher the speed of the motor the stronger will be the solenoid's pull, and the more rapidly will its core cut out the resistance in series with the coil, increasing the current flow through the armature and consequently the braking effect. Patent No. 679,760.

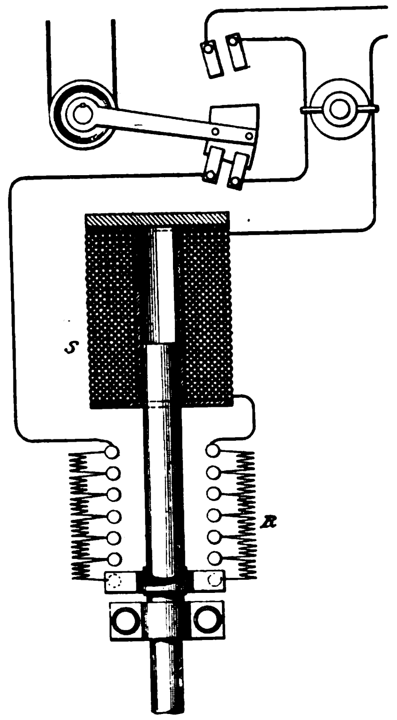


FIG. 4.—ELEVATOR CONTROLLER.

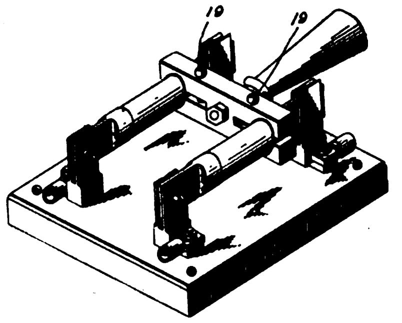


FIG. 5.—SWITCH IN NORMAL POSITION.

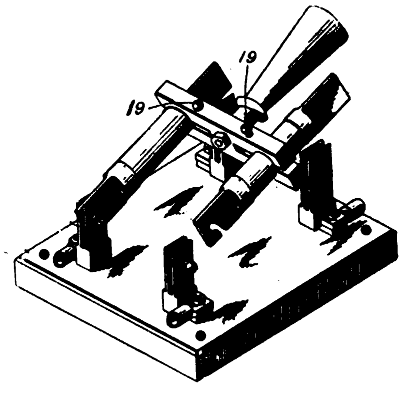


FIG. 6.—SWITCH WITH FUSE BLADE PARTIALLY REMOVED.

Combined Switch and Fuse Holder.—A rather ingenious method of combining a double-pole switch and fuse-block or holder has been patented by Geo. E. Linton, and is illustrated herewith. The arrangement consists of substituting an enclosed fuse with flat copper terminals for the usual blades of a switch of the knife-blade type. Fig. 5 shows the switch in its normal position for service, and Fig. 6 shows it with one of the fuse blades partly removed. The tubes containing the fuses are secured in the insulating crossbar of the switch by means of the screws, 19. The construction of the pivot will be obvious from an inspection of the engraving. Patent No. 680,336.

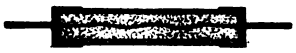


FIG. 7.—FUSE TUBE.

Convention of the American Institute of Electrical Engineers

The eighteenth annual meeting of the American Institute, which was held in the New York State Building at the Pan-American Exposition, Buffalo, August 20, 21, 22, 23 and 24, was one of the most interesting and successful that has ever been held by the Institute. The papers read were of particular interest, and the discussions following them were unusually full and valuable. The six days preceding the opening of the convention were devoted to entertaining the foreign guests of the Institute. The foreign guests were: Prof. Janet, MM. Marcel and Maurice Aubert, Courtier, David, Debeauve, Roux and de la Tour, of the Societie Internationale des Electriciens; Herr J. F. Ch. Janisch, of the Deutscher Elektrotechnische Verein; Prof. Gustav Gillon, of the Louvain University, Belgium; and Messrs. Copper, Cottam, Denham, McNott, Potts and Sayers, all of the British Institution of Electrical Engineers.

On Wednesday morning, August 14, about a hundred members of the Institute met at its uptown rooms, No. 12 West Thirty-first Street, New York City, where an address of welcome to the foreign guests was delivered, followed by a collation, the registration of names, and the distribution of Convention badges. On Thursday, August 15, the party visited the Crocker-Wheeler Works at Ampere, N. J., returning to New York for dinner that night. On Friday, August 16, a tour of the principal New York riverside power stations was made on a special steamer chartered for the purpose. The party met at the new Edison power-house at the foot of Thirty-eighth Street and East River in the morning, inspected this power-house, which is in a rather embryonic state just now, and then proceeded successively to the power-houses of the Manhattan Railway Company at the foot of Seventy-sixth Street, the Metropolitan Street Railway at the foot of Ninety-sixth Street, the Gold Street station of the Brooklyn Edison Company, and the Bay Ridge station of that company, returning to New York for dinner that night. On Saturday, August 17, there was no definite programme; the various guests were entertained by groups of members and individuals in various manners. On Sunday, August 18, all of the members going from New York to the Convention, together with the foreign guests, were taken up the Hudson River by a special steamer to Albany, where the night was spent, and on the following morning the party went over to Schenectady and inspected the works of the General Electric Company, leaving for Buffalo on a special train in the afternoon.

The formal opening of the Convention took place Tuesday morning, August 20, at the New York State Building, an address of welcome being delivered by the mayor of Buffalo. On the following morning a paper on "Synchronism and Frequency Indication" was read by Mr. Paul M. Lincoln, in which the author described a structurally-simple form of synchronism indicator which not only indicates positively when synchronism exists between two alternating-current machines, but also indicates which of the two machines lags in phase when they are out of synchronism. The instrument consists, broadly, of a small bipolar field magnet with a laminated core, the winding of which is connected to the bus-bars, and an armature carrying two coils mounted at right angles to each other and connected in parallel to the generator which is synchronized. In series with one of the coils is a non-inductive resistance, while an inductance is connected in series with the other coil for the purpose of obtaining a difference of time phase between the currents in the two coils. The connection is such that if the alternator lags behind the phase of the bus-bar current the armature shaft will revolve backward, its rate of revolution growing less and less as the difference in phase is decreased. When the alternator comes into phase with the bus-bar current the armature of the instrument comes to a standstill. If it goes beyond, the armature reverses and revolves in a forward direction. The instrument is also available as a frequency indicator by placing in series with the field coil a capacity of such value that at normal frequency the negative reactance of this capacity will equal, and therefore neutralize, the positive reactance of the field coil.

At the Wednesday session papers were also read by Messrs. Caryl D. Haskins on "Some Fundamentals of Electric Meters;" Harry P. Davis on "The Metering of Electrical Energy," and Prof. Wm. H. Browne, Jr., on "Power Factor Indicators." Mr. Haskins' paper discussed the relation between the torque, friction, aging of various parts and the local surroundings of watt-hour meters, and pointed out that friction is the main obstacle to making a direct-current meter always correct at all loads. The remedy suggested is to compensate for the friction instead of endeavoring to minimize or eliminate it, and to increase radically the damping load with relation to the possible friction load. Mr. Haskins expressed himself in favor of aluminum discs as compared with copper.

Mr. Davis' paper dealt more with the design of electric meters than with the practice of metering, most of the paper consisting of an interesting description of the Westinghouse induction motor-meter, in which the armature is an aluminum disc, corresponding to the short-circuited rotor of an ordinary induction motor. Referring to the metering of polyphase loads, Mr. Davis advocated the use of a single polyphase meter in preference to the use of either two or three individual wattmeters, pointing out that there would be much less danger of confusion in taking the readings.

Prof. Browne's paper was highly mathematical and gave an excellent résumé of the principles involved in the design of power factor indicators, together with a discussion of various types of such instruments and data applying to the various types.

In the discussion which followed the reading of the papers, Mr. W. S. Barstow expressed the opinion that the idle current used in starting induction motors should be metered and an income derived from it, while Mr. R. D. Mershon said that owing to the short duration of this starting current the income derived by charging for it at any reasonable price would be inconsiderable. Mr. C. P. Steinmetz thought that central stations should exercise supervision over the installation of induction motors and prevent the use of machines taking a large idle current.

The references to the idle current of induction motors led to a very animated discussion of the relative merits of direct-current and alternating-current machines, alternating-current advocates urging the usual arguments as to simplicity, durability and small cost of maintenance as characteristics of the induction motor, while the direct-current advocates were equally urgent in pointing out the superiority of the direct-current motor in point of speed control, disturbance of regulation, power factor and efficiency at full load and overload. Mr. Steinmetz caused considerable merriment by stating that the induction motor is undoubtedly best for use in a powder mill, while the superiority of the direct-current motor for elevator service could not be contested; between these two extremes there was much debatable ground, and it was the province of the engineer to decide in each particular case which type of motor is preferable for that case.

On Thursday, August 22, five papers were read, the first being one by Prof. W. S. Aldrich and Mr. Geo. W. Redfield, on "The Performance of an Artificial 40-Mile Transmission Line." The paper described an artificial line which was set up in the electrical engineering laboratory of the University of Illinois, and gave considerable data taken from tests made with the line. Among other points brought out by these tests was the fact that in operation the generator should not be driven connected to an unloaded transmission line in which the rise in voltage due to resonance may be comparatively large; it is advisable always to have induction motors or some other inductive reactance connected in circuit.

The next paper read on Thursday was one by Prof. F. A. C. Perrine, on "The Elements of Design Particularly Pertaining to Long-Distance Transmission." Prof. Perrine pointed out that the most important question connected with long-distance transmission is regulation, and that this is only slightly affected by the resistance of the line, its capacity being the chief disturbing factor, and the self-induction of the circuit being next in importance as a disturber of regulation. With variable loads capacity and inductive reactance cannot be made to constantly neutralize each other, for the reason that the capacity effect is constant, while the inductive effect varies with the load; with a long line supplying a load wholly lagging in character, the conditions for regulation are the worst possible. The most important disturbance due to line capacity is that of the regulation of the transformers and generators connected in circuit, a leading current taken from such apparatus having the effect of increasing the voltage. He also pointed out that high voltages entail very great charging currents, citing as an example that a line 100 miles long operated at 50,000 to 60,000 volts and a frequency of 50 cycles required a charging current of somewhat more than 2000 kilovolt-amperes. Such a charging current renders commercially impracticable the transmission of a smaller power than about 3000 kilowatts, unless the capacity of the line be neutralized by means of inductance. He further stated that electrical tension resulting in brush discharges, renders the use of wires smaller than ⅜ in. in diameter for lines operated at 50,000 to 60,000 volts dangerous practice, involving important energy losses from these discharges, independent of leakage over the surface of the insulators.

Prof. Perrine's paper was followed by one on "The Induction Motor and the Rotary Converter," by Mr. Chas. F. Scott. The paper presented nothing that is not already well known in engineering circles, and consisted practically of a comparative summary of the characteristics of the induction and synchronous motors, together with a discussion of the relations of the induction motor and the rotary converter to transmission systems. Mr. Scott favored the induction motor on account of its greater simplicity, the absence of the necessity for synchronizing, and the much smaller amount of auxiliary apparatus required for operation. His conclusion was that the induction motor and the rotary converter represent the survival of the fittest, and confirmed the judgment of those engineers who have persistently advocated their use.

Following Mr. Scott's paper, Mr. Steinmetz read an extremely important paper entitled "Theoretical Investigations of Some Oscillations of Extremely High Potential in Alternating High Potential Transmissions." Mr. Steinmetz pointed out that in circuits having capacity, any change in circuit conditions, such as pulling a switch, extinguishing a short-circuit, or starting up a generator, will produce electrical oscillations which may be very rapid and result in a destructively high potential. The paper contained an exhaustive mathematical investigation of the character of these oscillations, and several numerical examples were worked out to illustrate their effect. In one example, Mr. Steinmetz considered the case of a transmission line operated at 20,000 volts and having a resistance drop of 8 per cent, an inductance drop of 15 per cent, and requiring a charging circuit of 8 per cent of the full-load current, which was taken at 100 amperes. The resistance drop in each set of transformers was assumed at 1 per cent, and the inductive drop at 2½ per cent, so that the total resistance drop in the line and both sets of transformers wôuld be 10 per cent, and the total inductive drop 20 per cent of the impressed e.m.f. Under these conditions the rise in voltage due to rupturing the line under short-circuit would be approximately tenfold or about 282,800 volts maximum, the maximum impressed e.m.f. being 28,280 volts. Mr. Steinmetz's conclusions were that the oscillations referred to are the most important source of destructive high-voltage phenomena in high-potential circuits containing inductance and capacity; that these oscillations are independent of frequency, wave form and impressed e.m.f., but depend upon the condition under which the circuit is changed; that the oscillations caused by connecting a generator to a transmission line are not of dangerous potential, but those produced by opening the transmission circuit under load may give rise to destructive voltages, and the oscillations caused by opening a short-circuited line are liable to produce voltages far beyond the strength of any insulation, but that the voltages thus produced are moderate if the opening of the circuit occurs about at the instant when the current wave is passing through zero.

The final paper read on Thursday was one on "The Control of High-Potential Systems of Large Power," by Mr. E. W. Rice, Jr. This paper described the latest types of cellular oil switches built by the General Electric Company for the Metropolitan Traction Company and the Manhattan Elevated Railway Company in New York. The type of switch built for these stations is the latest development in this line and has never failed to successfully and noiselessly open a circuit of 1200 or 1300 kilovolt-amperes at any voltage up to 40,000. The switches for the Manhattan Railway station differ from those in the Metropolitan Traction station in being operated by means of a small motor instead of pneumatic mechanism.

In the discussion which followed the reading of the papers on Thursday, Prof. George D. Shepardson pointed out that assuming the discharge from high-voltage conductors to be a function of the diameter, aluminum conductors would be preferable to copper, on account of the greater diameter for a given resistance per unit of length. With reference to Mr. Scott's condemnation of the synchronous motor, Dr. A. E. Kennelly expressed the opinion that in many cases a mixed system would be best, such a system being more flexible than one in which induction motors alone were employed. Mr. Steinmetz said that the synchronous motor is entirely suitable for large units and the induction motor is similarly suitable in small units. He had designed induction motors to the extent of 100,000 kilowatts aggregate capacity, and synchronous motors to the same extent, and he believed that synchronous motors are preferable to induction motors wherever they can be used. He pointed out that while the starting torque of a large induction motor is larger than that of a synchronous motor, the latter has a larger air-gap and a power factor of from 95 to 100 per cent, and can be adjusted to be devoid of disadvantageous action on the generator, or even to have a beneficial action on the circuit. He challenged the statement in Mr. Scott's paper that a squirrel-cage induction motor can be started on 1½ times its normal running current. Both motors "break down" under excessive load.

On Friday, August 23, Mr. L. B. Stillwell read a paper on "A Description of the Niagara Falls Transmission Plant," and Mr. A. J. Wurts read a paper on "The Development of the Nernst Lamp in America." A large part of Mr. Stillwell's paper was historical, being a résumé of the preliminary plans and the work of carrying them out. The paper is a valuable record in that it constitutes a source of complete information concerning the Niagara plant as it exists to-day. Mr. Stillwell considered that the wisdom of the selection of 25 cycles as the frequency for the plant has been amply vindicated, although he personally considers 30 cycles preferable. Incandescent lamps are operated from the 25-cycle circuits, but the satisfactory results obtained are due largely to the fact that the shape of the wave given by the generators is flatter than a sine wave. The load curves presented in connection with the paper show that the local load varies between 13,200 kilowatts and 15,700 kilowatts, this rather unusual uniformity being due to the fact that nearly all of this load consists of industrial machinery, the operation of which is continuous and the demand for power nearly constant. The long-distance load varies between 3300 and 15,600 kilowatts. Comparing the Niagara plant with a steam plant of the same output, Mr. Stillwell estimated that the coal necessary for the latter at the rate of three pounds per kilowatt-hour at the switchboard would be over 800 tons per day.

Mr. Wurts' paper is printed almost in full on other pages. In the discussion of this paper, Mr. John W. Howell challenged the value of the Nernst lamp rather mercilessly, emphasizing the points of disadvantage, such as the excessive starting current, the necessity for ballast resistances, etc. Mr. Stinmetz said that it was not fair to compare the Nernst lamp in its present state with the incandescent lamp, which has been in use for 20 years, and pointed out that the candle-power of the Nernst lamp is not comparable with that of the incandescent lamp because of the superior quality of light given out.

On the final day of the convention, Saturday, August 24, Mr. Albert H. Armstrong read a paper entitled "Notes on Modern Electric Railway Practice," and Mr. Ernest J. Berg read one on "Electric

Railway Apparatus." Both papers were devoted chiefly to a discussion of the relative merits of direct-current and alternating-current motors for electric traction, and the conclusion of both authors was that, except in the case of long lines and infrequent train stops, direct-current motors are preferable to alternating-current machines. Prof. Gillon, of Belgium, gave some details of the high-speed polyphase traction experiments which had been made at Berlin with a potential of 10,000 volts, and expressed the opinion that under certain conditions with respect to starting, this system is applicable where the direct-current system would fail. He pointed out that polyphase motors can be made to give as large a starting torque as may be necessary by momentarily increasing the impressed e.m.f. Mr. L. B. Stillwell brought out the fact that objections to the sub-station system (alternating transmission and converters) are that a number of points of supply require skilled attendance, and that the amount of reserve sub-station apparatus was out of proportion to the reserve apparatus at the generating plant. Moreover, in large sub-station systems, the car or train acceleration is limited by fluctuations at the sub-stations, which may be extreme at these points, while the power-house fluctuations are moderate. He also pointed out the fact that the system to be used in any case must be worked out for the specific case under consideration.

NEW BOOKS.

A School Chemistry; Intended for use in High Schools and in Elementary Classes in Colleges. By John Waddell, B. A. New York: The Macmillan Company. 291 pages, 5 x 7½ ins.; 90 illustrations. Price, $1.

This little volume was written, so the author says, in consequence of his experience in examining students in chemistry. He finds that all beginners, both dull and clever, meet with the same kind of difficulties, the chief difference being that the clever ones are more easily helped over their difficulties. The main trouble seems to be, according to the author, that ordinary works on chemistry introduce the student to the atomic and other chemical theories before he has had sufficient experimental acquaintance with chemical facts to grasp the theories intelligently. He therefore begins with water, and not only that, but the simplest experiments with water. First freezing, then distillation, then the solution of well-known substances in water and finally electrolysis of water. This brings the student to hydrogen and oxygen, which are treated in a similar manner. The atomic theory is not mentioned, so the author says, until most of the facts upon which Dalton founded it are in the possession of the student.

It will be seen that the book is of a very elementary character, but as the author has taken a good deal of pains to make it accurate, and in describing industrial processes to mention only those in use at the present time, omitting those that have become obsolete, we can recommend the work for beginners.

A B C of the Telephone. By James E. Homans, A. M. New York: Theo. Audel & Co. Cloth: 335 pages, 7½ x 5 ins.; 268 illustrations and diagrams. Price, $1.

As indicated by its title and set forth more particularly in the preface, this book is an elementary treatise on telephony. Its object is to give in simple language, unencumbered by technicalities, an account of the evolution of the telephone and of the present state of telephone engineering; but like many another book which tries to present a technical subject in a manner suited to the general reader, it becomes at times a little vague, and in the striving for simplicity lapses into crudity. With these almost necessary limitations, however, it fulfills its mission very well, and covers its chosen field pretty broadly.

The opening chapter gives a general account of the telephone apparatus and its operation. Then comes a brief survey of the theory of sound and the principles of electricity, followed by a sketch of telephone history. The receiver, the transmitter and other apparatus, are treated more in detail, and there is a long account of switchboards and exchange accessories. Chapters are devoted to party lines, private systems and automatic exchanges; pole lines and cables are generally described, and the work is brought up to date by a reference to Pupin's application of inductance coils. The book is concluded by a chapter on definitions, "dont's" and troubles.

NOTES.

Another Good Mind Gone Wrong.—A New England weekly paper thus describes a storage battery put in as an auxiliary to the electric-railway system of that section:

> The auxiliary power station of the L. & B. Street Railway on Bedford Street is fast approaching a working condition. The "Booster" is practically a high storage battery and consists principally of a series of six rows of tanks the entire length and the same in depth, each with its complement of copper and zinc plates. This battery, when charged with electricity from the feed wire from the power station, will make a "booster" that will do away with all delays for want of power at this end of the line.

The Sixth Convention of the International Association of Municipal Electricians.—Owing to the unfinished condition of the Natural Food Company's Convention Hall at Niagara Falls, where the meetings of this association were to have been held during the sixth annual convention, September 2, 3 and 4, the meetings will be held in the banquet hall of the International Hotel. The convention promises to be an unusually attractive, one, a number of papers on thoroughly practical subjects having been prepared. In addition to the proceedings of the convention proper, the entertainment committee has provided for several attractive pleasure trips, including carriage drives, a ride down the Gorge road by moonlight with search-light effects, and a steamboat ride on the "Maid of the Mist."

Annual Meeting of the Illinois State Electric Association. —The next annual meeting of this association has been changed by the executive committee from November 27 to September 24 and 25. The convention will be held at Rock Island, Ill., and promises to be interesting and well attended.

Invitation to the G. A. R. Members at the Cleveland Encampment.—A cordial invitation is extended to members of the Grand Army of the Republic and their friends who intend to visit Cleveland, Ohio, during the encampment on September 9, and who are interested in telephone work, to utilize as headquarters the offices of the Consolidated Telephone Company, the Inter-Ocean Telephone & Telegraph Company, and the Century Telephone Construction Company, which are located on the second floor of the Electric Building. Visitors may have their mail forwarded to these offices, and the three companies named will be glad to supply any information they can and to do everything to make visitors comfortable.

Where Ignorance Is Bliss.—The British "Free Lance," taking to task its lay contemporaries for their pseudo-science, writes thus: "As an instance of the pseudo-scientific rubbish we are so constantly treated to by the lay papers, we were told that a 'short-circuit' of 'electric wires' was responsible for a fire. An electric current for the want of, or for the breaking down of, proper insulation, may become 'short-circuited,' and so cause 'sparking,' and thus a blaze; but if the insulation is satisfactory, and the wire does not offer too great a resistance, an electric current can be sent over a long or short circuit with equally satisfactory results." As an instance of the blind leading the blind this is a gem.

The Ohio Electric Light Association.—The seventh annual convention of this association was held August 20, 21 and 22, at Hotel Victory, Put-in-Bay, Ohio. The convention having been held so late in the month, it is impracticable for us to present a report of the proceedings, which, judging by the programme, were of much practical value. Among other papers read were one by W. D'A. Ryan on The Relative Merits of Open and Enclosed Arc Lights for Street Illumination; one by E. Heitmann on The Inductor Type of Alternator; one by J. C. Hallberg on Regulating Devices for Alternating-Current Series Circuits; one on The Selection and Maintenance of Meters, by M. E. Turner, and one on Single-Phase Alternating-Current Motors, by E. S. Pilsbury.

ESTABLISHED 1889.

American Electrician,

WITH WHICH IS INCORPORATED

Electrical Industries.

CECIL P. POOLE, Editor.
W. H. ONKEN, Jr., Associate Editor.

Published on the first of each month by the

American Electrician Company,

NEW YORK: 120 Liberty Street.
CHICAGO: Monadnock Block.
PHILADELPHIA: 929 Chestnut Street.
LONDON: Hastings House, Norfolk Street, Strand.

JAMES H. McGRAW, President.
A. E. CLIFFORD, Vice-President.
C. E. WHITTLESEY, Treasurer.
E. E. WOOD, Secretary.

Subscription, - $1.00 Per Year.
In the United States, Canada and Mexico.
FOREIGN COUNTRIES, $2.00.

NOTICE TO ADVERTISERS.

Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

IMPORTANT NOTICE.

Intending subscribers are warned not to place subscription orders with persons who cannot show written authority to take such subscriptions and make collections therefor, as the paper will not undertake to fill orders placed with alleged agents acting without such written authority.

Subscribers requesting a change of address should invariably furnish both the old and the new address.

Vol. XIII. SEPTEMBER, 1901. No. 9

The American Electrician has a larger paid subscription list than any other electrical journal in the world.

CONTENTS

The New Power House Equipment of the Consolidated Electric Light & Power Company, Birmingham, Ala., by J. R. Williams 421
Parabolic Reflectors for Searchlights 424
The Service Plants of the Pan-American Exposition 425
Commercial Types of Steam Superheating Apparatus, by Geo. A. Hutchinson 426
Steam Tables, by Chas. L. Hubbard 432
Pulverized Fuel, by R. A. Douglass 434
Parallel Operation of Alternators, by A. S. McAllister 435
Curves for Showing the Charge Remaining in a Storage Battery 436
Development of the Nernst Lamp in America, by Alexander J. Wurts 437
Abstracts from Foreign Contemporaries 442
Some Recent Electrical Patents 444
The Annual Convention of the American Institute of Electrical Engineers 445
New Books 447
Notes 447
Editorial 448
Design for a 35-Light Incandescent Dynamo, by Cecil P. Poole 450
Water Column Connections, by C. W. Obert 452
Efficiency of Telephone Generators, by W. S. Henry 453
Stripped Railway Motor Armatures, by Frank Berry, Jr 454
Lessons in Practical Electricity 454
Letters on Practical Subjects 455
Electrical Catechism 457
Queries and Answers 458
Solenoidal Electric Elevator Controller at the Exposition 459
Homopolar Motor Meter 460
Three-Wire Secondary Distribution From Transformers 461
New Apparatus and Appliances 462
The Bernard Company at the Pan-American Exposition ..... Adv. 35
Personals ..... Adv. 35
Trade Publications ..... Adv. 35
Business News ..... Adv. 36

"Ohmic" Resistance.

In early days, before electrical nomenclature had been systematized, and when names were applied haphazard or not at all, there arose a necessity for discriminating between resistance pure and simple and other properties and effects (such as reactance, counter e.m.f., polarization, etc.). This led to the use of the word "ohmic" as a qualifier to indicate the sort of resistance that Ohm had in mind when he formulated his classic law, in distinction to "apparent" resistance, "spurious" resistance, etc. With the development of the existing system of nomenclature, however, the term "ohmic resistance" became needless; the other properties and effects which exert an influence similar to that of resistance have all been analyzed and named, and there is no reason why the plain term "resistance" should not be perfectly well understood without being prefixed by "ohmic." The use of the compound term is a definite hindrance to the clarification of the system, and should be discontinued by writers and instructors who adhere to it from force of habit.

◆

Alternating vs. Direct-Current Motors.

The old controversy over the respective merits of the induction motor and the direct-current machine broke out afresh at the Buffalo meeting of the American Institute of Electrical Engineers, and the discussion waxed warm several times during its progress. The familiar claims were made on both sides, the alternating current advocates declaring that the simple armature construction, absence of commutator and brushes, etc., of the induction machine more than counterbalanced the flexibility of speed regulation, unity power factor and lesser disturbance of regulation possessed by the direct-current motor. With equal vigor the direct-current adherents expatiated upon the enormous starting current required by a squirrel-cage motor and the smaller starting torque per ampere obtainable from it, together with the fixed speed, extremely small armature clearance and fractional power factor characteristic of all induction motors.

Those contending for alternating current weakened their position conspicuously by claiming all of the cardinal virtues for the induction motor in every class of service except railway; here, the despised direct-current motor, with its prohibitive complications, appeared to be ideal as compared with polyphase equipment with motors in tandem or any other way. The disinterested hearer instinctively speculated upon the possibility that this radical exception to the universal excellence of the induction motor might be in some way connected with the high regard which some of the speakers appeared to entertain for the rotary converter. However that may be, the exception was rather surprising in view of the blanket claims made by its champions for the induction motor in general.

That the direct-current motor is superior to the induction machine for railway service is almost obvious. But if this is conceded, then it follows that the same is true with regard to elevator service, crane work and any other class of operation involving frequent starts under heavy load and variable speed at reasonable efficiency. Indeed, Mr. Steinmetz, than whom no one is better qualified to speak on this subject, said that the claims of superiority made for the direct-current motor in elevator service could not be contested. It is equally plain to dispassionate and impartial engineers that there is a field for the alternating-current motor in which it is pre-eminently the superior of its older rival. For service requiring or permitting continuous operation at one speed, or even two, the direct-current motor cannot compare with the induction machine. But it is not practical to make a final comparison of the two machines on the basis solely of the local conditions of operation. This is well enough in considering the installation of a few small motors where either kind of current may be obtained. When it comes to determining the type of apparatus to be used for a complete generating, transmitting and power-converting plant, then one has to face an engineering problem into which the characteristics of the whole plant enter, and the nature of the load on the motors may or may not be the controlling factor of the problem.

All of the propositions advanced in the preceding paragraph are so thoroughly well recognized by impartial authorities and are so perfectly fair to both sides that any extended general discussion, such as that indulged in by partisans of the two systems at the Institute convention, would appear to serve no purpose beyond a recital of the advantages and disadvantages of the two motors, and these are already so well understood as to require no reiteration.

Steam Tables.

The title of the article on steam tables which appears in another part of this number does not indicate the importance of the article to young engineers (or any others who have neglected to study the properties of steam). It is possible that many engineers have used their steam tables for the purpose merely of determining the temperature or volume of steam at some pressure, and have never taken the trouble to apply to their everyday work the other information contained in the tables. Anyone coming within this classification should read Mr. Hubbard's article at least twice, and preferably three times, slowly and analytically. There is nothing new in the article; merely practical common sense—which has monetary value to the absorber.

◆

Waste Fuel.

One constantly hears all sorts of statements regarding the millions, billions, etc., of heat units that are going to waste by reason of the failure to utilize the culm piles that accumulate in mining districts, but the force of most arguments on this subject is blunted or lost on account of the false premises on which such arguments are based. As pointed out by Mr. Douglass in another column, the assumption that such beds of culm consist almost wholly of available fuel is erroneous. All of them contain a very large percentage of slate, rock and dirt, and those that are richest in real combustible are subject to internal spontaneous combustion. This latter characteristic, however, obviously does not enter into the consideration of using fresh culm either in pulverized form as fuel in a boiler furnace or in its original form (cleansed of non-combustibles) for making producer gas to drive gas engines.

Of the two methods of utilization, the gas-engine plan appears rather more attractive, particularly in cases where the mines are not far distant from towns of considerable size. Then, the producer plant could be located at the culm pile and alternators driven by gas engines could be operated on the spot and the energy transmitted electrically to neighboring towns and cities for distribution. On the other hand, the use of the culm in pulverized form under boilers is less restricted geographically. It is highly improbable, however, that the redemption of anthracite culm will be effected profitably until the coal supply becomes so depleted as to force prices far beyond any figures at which coal has ever been sold in this country.

◆

The "Dummy" Locomotive.

There still remains in more or less active service on some short suburban roads a considerable number of mechanical relics commonly known as "dummy" locomotives—the type used on all elevated railways. Why this is true is something of a mystery in these days of enlightened engineering. It is a somewhat pathetic object lesson to watch one of these toy-like pieces of machinery toiling along with four or five coaches, emitting gasps and consumptive wheezings that almost "work on one's feelings," while an electrically driven train on the same or a parallel track speeds away from it with ease. This is neither an assumed nor an exaggerated case; we have witnessed such an occurrence repeatedly within the past few weeks.

It is frequently argued that the better acceleration and freer operation of electrical trains as compared with those hauled by these small locomotives are due to the fact that the locomotives are almost invariably overloaded. It does not require expert knowledge to ascertain at a glance that the overloading is practised; but it is also true that what constitutes a serious overload for a "dummy" locomotive and precludes the adherence or even approximation to schedule time has no visible effect upon the performance of an electric motor equipment. However, the superiority of service obtainable with electrical equipment as compared with small steam locomotives is so thoroughly established and the extravagant fuel consumption of the latter is so notorious as to remove a comparison of the two beyond argument. It is indeed a puzzle to account for the retention in service of these poor little mongrel machines, of which the day of usefulness has gone forever.

◆

Efficiency and Economy.

It is too much to expect that technical terms will ever become literally descriptive or their usage consistent; having inherited from feminine ancestry the prerogative of saying one thing and meaning something quite different, men will naturally progress from bad to worse, and may wind up by making universal the Chinese custom of reversing everything. A good start in this direction has been made in the contradictory usage of the terms "efficiency" and "economy." We speak of a generator of 90 per cent efficiency, and in the same breath refer to lamps of 3½ watts "efficiency." The absurdity of the latter usage is entirely obvious, even leaving aside its inconsistency with the other application of the term. It would be somewhat better etymologically, and infinitely more descriptive, to refer to lamp efficiency in terms of candle-power instead of watts; thus, 0.286 candle efficiency would mean that for each watt of power 0.286 candle-power would be obtained. By this method, the stated efficiency of a lamp would vary with its physical efficiency, as it should, and as is true in the case of other apparatus; a 4-watt lamp would have an efficiency of 0.25 candle. Under the present abominable usage, the efficiency of a lamp expressed in figures varies inversely as its actual translating efficiency.

The application of the word "economy" is similarly confused. Steam engines are said to show an "economy" of so many pounds of steam (water) per horse-power-hour; consequently, the more wasteful an engine is, the higher will be its "economy." It would be much more logical to apply the term "economy" to the energy utilized per pound of steam passed through, which could be expressed in foot-pounds more conveniently than in horse-power-hours. Thus, an engine taking 16½ pounds of steam per hour per indicated horse-power could be said to have an "indicated economy" of 12,000 (foot-pounds per pound of steam). This, moreover, would facilitate the expression of small differences without recourse to fractions or decimals. And as in the case of the lamp, the engine showing the better performance would have the higher economy, numerically expressed. In both cases it would usually be unnecessary to specify more than the figures, as 286 and 12,000 in the above examples.

The use of the two terms under discussion in the manner suggested need not necessarily abolish the custom of expressing the intake of a piece of apparatus in terms of its output. There is not the least disadvantage in referring to the intake of a lamp as so many watts per candle, or the intake of an engine as so many pounds of steam per horse-power-hour, but the practice of applying the terms efficiency and economy in this sense is distinctly irrational.

DESIGN FOR A 35-LIGHT INCANDESCENT DYNAMO.

BY CECIL P. POOLE.

The present machine is of the same general design as the 3-h.p. motor described in the September, 1900, issue of this paper. The field magnet consists of a cast-iron frame into which are set wrought-iron magnet cores having cast-iron pole-pieces, as shown in the semi-cross-section, Fig. 1. The cast-iron ring is preferably made in a single piece and the wrought-iron cores are turned to a very slight taper and drawn into holes in the yoke ring by means of a bolt and heavy washer from the outside. Unless the builder has excellent machine-shop facilities, however, and is an expert machinist, this construction will be found rather difficult, as it is necessary to have a perfect fit between the taper of the magnet core and that of the hole in which it is seated.

As an alternative the magnet frame can be cast in two pieces, the division being along the line *X*, Fig. 2. If the motor is built in this way, each half must be chucked and the joint faced off fairly smooth, although it is not necessary to have a perfect joint, as no magnetic lines of force pass across the joint. After truing up the abutting faces of each half of the magnet ring, the two halves should be clamped together with 1/32 in. of cardboard in between them and four straight holes bored for the reception of the field-magnet cores. A field-magnet core is shown by Fig. 3. The cast-iron pole-pieces must be accurately fitted to the ends of the cores and pinned permanently in place with iron pins.

The magnet ring and pole-pieces must be of the best grade of pig iron obtainable. The magnet cores should be made of Norway wrought iron. The corners of the pole-pieces should be heavily rounded so that no sharp edges are left. The length of the pole-piece parallel with the shaft is the same as its width at right angles to this dimension. The outside diameter of the magnet ring is 20⅝ ins. The extreme breadth of the ring parallel with the shaft is 8 ins. The other dimensions are as below:

	Inches.
Inner diameter of yoke ring	17⅝
A—Bore of armature chamber	8
B—Axial length of pole-face	4
C—Width of pole-piece, tip to tip, in a straight line	4
D—Radius to which pedestal seat is cut	8½
E—Thickness of yoke ring	1½
F—Distance between ribs	7
G—Width of plane surface back of magnet coil	6⅛
H—Height, base line to armature center	12
O—Axial length of pedestal seat	4
P—Straight-line width of pedestal (width of pedestal seat is the same)	7
Q—Length of pedestal foot, commutator side	7

The dimensions of the magnet core (Fig. 3) are as follows:

	At		
	y	m	p
Diameter, inches	3 1/16	3 3/16	3 1/16
Length, inches	2	3	1¼

Fig. 2 is an edge view of the field-magnet frame, including one journal pedestal shown in perspective, and the other in cross-section. After fitting the magnet cores into place in the ring, the pole-pieces should be bored and the pedestal seats cut, at one setting of the frame. Fig. 4 is a cross-section of the armature core, showing the details of construction. The discs are mounted on a cast-iron drum, which is provided with a flanged head and a hub, *J*, at one end, the other end being open. The discs are clamped in place by a cast-iron ring which is provided with a hub, *I*, and a flange, similar to those at the other end of the drum. The clamping ring is drawn to place by means of eight 3/16-in. bolts passing through holes in the clamping ring and tapping into the end of the cast-iron drum. The center lines of two of these bolts are indicated at *s*, *s*. The cast-iron drum must have a key-seat cut in it so that the discs may be positively driven.

Both the hub on the end of the drum and that on the clamping ring should be keyed to the shaft, so that there will be no liability to displacement. At each end of the core construction a disc of fiber 1/16 in. thick should be provided, as indicated by the heavy black lines in the engraving. These discs must be toothed exactly like the core discs, so that the ends of the magnetic core will be entirely covered.

The iron core discs are 7¾ ins. in diameter, with a central hole 3 ins. in diameter, and 36 slots 9/32 in. wide by 1 1/16 ins. deep; the slots have parallel sides. The discs must be of the best grade of charcoal iron, 1/40 in. thick. The dimensions of the armature-core structure are as follows:

	Inches.
I—Length of hub clear through (also length of flanges)	1¾
Bore of this hub	1¼
J—Length of hub clear through	1 13/16
Bore of this hub	1⅛
K—Diameter of hubs	2¼
L—Internal diameter of core drum	2¼
M—Outer diameter of core drum	3
N—Diameter of flange and clamping ring	5 9/16
Thickness of flange and clamping ring	⅜

The two journal pedestals are exactly alike and made of ordinary cast iron. The base must be turned accurately to conform to the circle to which the pedestal seat on the magnet frame is machined. The standard, or pedestal, is an open frame of ½-in. metal; the box is of the ring-oiling type, with a single ring hung exactly midway of the journal. Fig. 5 is a transverse cross-section of the pedestal and box. The box is bushed; the bushing may consist of a brass casting turned to shape, or it may be made by babbitting a piece of thin brass tubing, the outer diameter of which is a snug fit in the box.

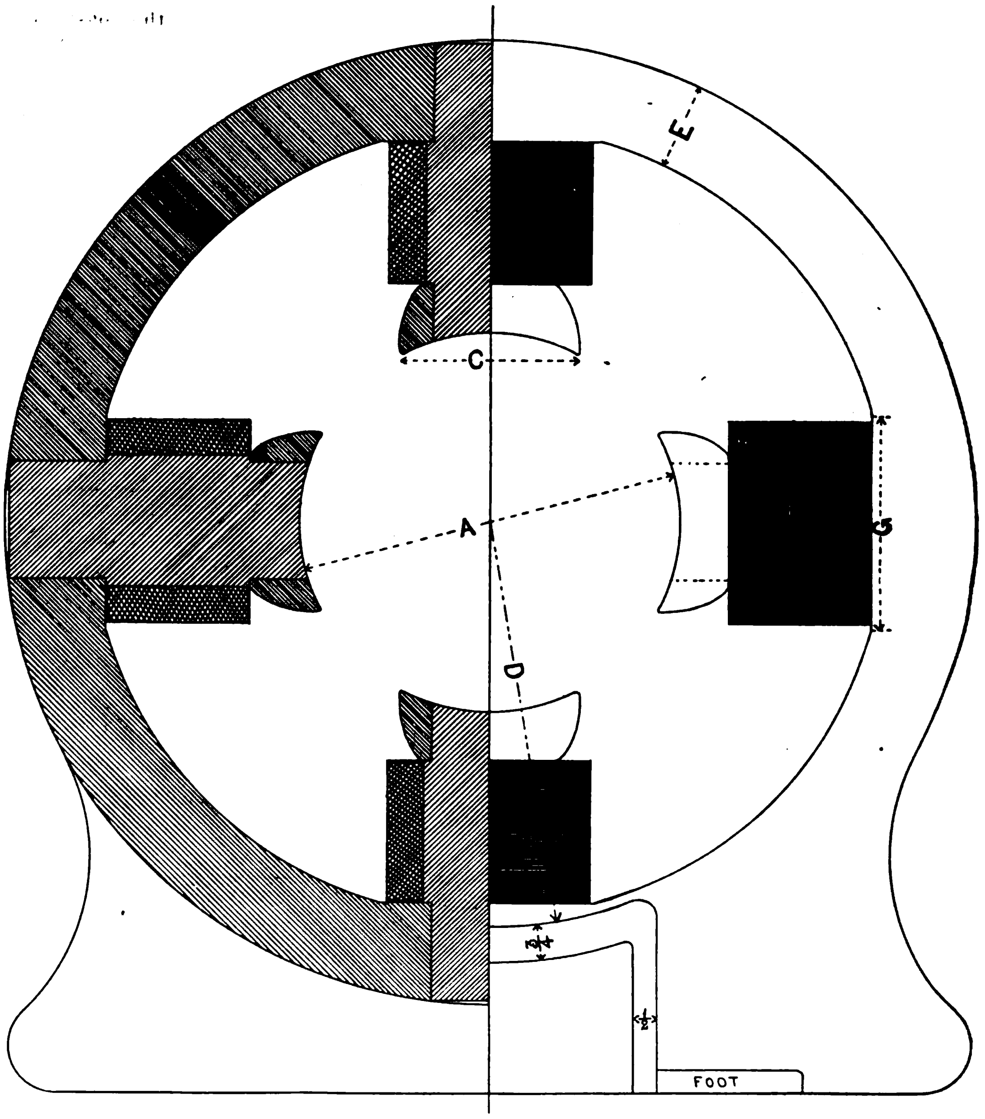


FIG. 1.—END ELEVATION OF MAGNET FRAME; SEMI CROSS-SECTION.

The oil slot across the center of the box must be provided with a suitable covering to exclude dust. Each pedestal should be bolted to the magnet frame with two ⅝-in. cap screws. The pedestal and box measurements are as below:

	Inches.
P—Widest part of standard	7
R—Axial length of oil well	2¾
S—Inner length of oil well	2
T—Inner width of oil well	3
t—Inner radius of oil-well bottom	1½
Q—Outside diameter of box	2¼
V—Inside diameter of box	1½
W—Outside length of box	4
Y—Length of bushing	3¼
Bore of bushing	1
Z—Projection of box beyond oil-well wall	15/16
Diameter of oil ring	2¼
Bore of oil ring	1⅞
Width of oil ring	⅜

A bearing must be turned on the outside of the inner end of the pedestal on the commutator side of the machine, as indicated in Fig. 2, to accommodate the brush-holder rigging, which may be copied from any of the standard makes. Four sets of brushes are required, each comprising two carbon brushes ¼ in. thick and ¾ in. wide; the four sets must touch the commutator exactly 90 deg. (18 segments) apart, center to center. The commutator must have 72 segments, and may measure 3 ins. along the shaft, extreme length. The commutator core must be bored to fit the portion, *c*, of the shaft, and key-seated to correspond. The diameter of the barrel should be not less than 3 ins., nor more than 4 ins., and the diameter measured at the connecting lugs must not exceed 7 ins. The brush surface, measured parallel with the shaft, must be 2 ins. long. It will be best to buy the commutator complete from one of the several makers of this class of apparatus.

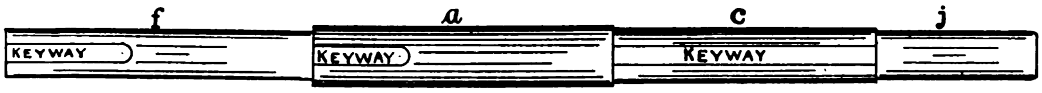


FIG. 6.—THE ARMATURE SHAFT.

Fig. 6 is the armature shaft. The key-seats are all ⅜ in. wide and 3/16 in. deep. The dimensions of the shaft are below:

	At f	At a	At c	At j	Total Length
Diam., ins.	1	1¼	1⅛	1	
Length, ins.	6 7/16	6 1/16	5 3/16	3 5/16	21

The field-magnet coils may be wound directly on the core or on bobbins made of thin vulcanized fiber. If they are wound directly on the cores, the latter must be wrapped first with three layers of unbleached cottons and painted with shellac varnish, two circular coil heads of hard fiber being first fitted to the large part of each core. The coils consist of No. 18 single cotton-covered wire, wound to a depth of 1⅜ ins. exactly. The exact number of turns is immaterial, except that all four coils must contain the same number of turns, and as many turns should be put on as can be got in the space available. With careful winding the builder should get 30 layers in each coil, and 60 turns per layer, making 1800 turns per coil.

Should the reader prefer to wind the coils in bobbins, the magnet core need not be wrapped, of course. After each coil is completed, secure the outer end and cover the outside layer with unbleached cottons two layers deep, heavily varnished. Fig. 7 indicates how the field coils should be connected up.

There are 72 armature coils, each consisting of six turns of No. 13 double cotton-covered magnet wire. The coils are wound around two ½-in. pegs set 10½ ins. apart, center to center, all of the turns being wound on top of each other, none side by side. Fig. 8 shows one of the coils wound on the two pegs and ready for shaping. After completing the winding of each coil the wire should be temporarily secured by means of linen threads tied around the coil at each end and in the center of each side of the coil.

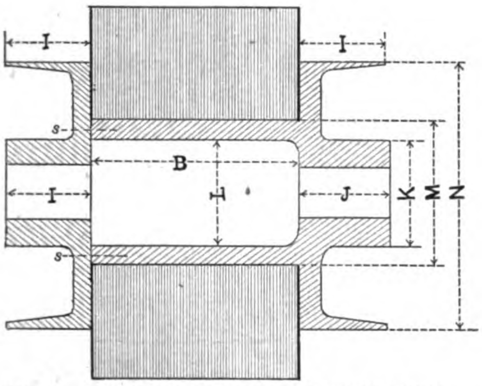


FIG. 4.—CROSS-SECTION OF ARMATURE CORE.

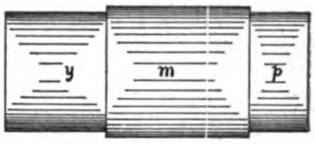


FIG. 3. MAGNET CORE.

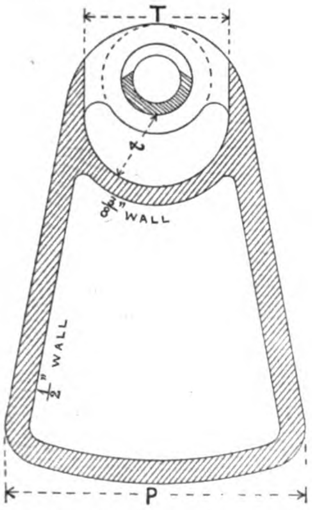


FIG. 5.—CROSS-SECTION OF A PEDESTAL AND BOX.

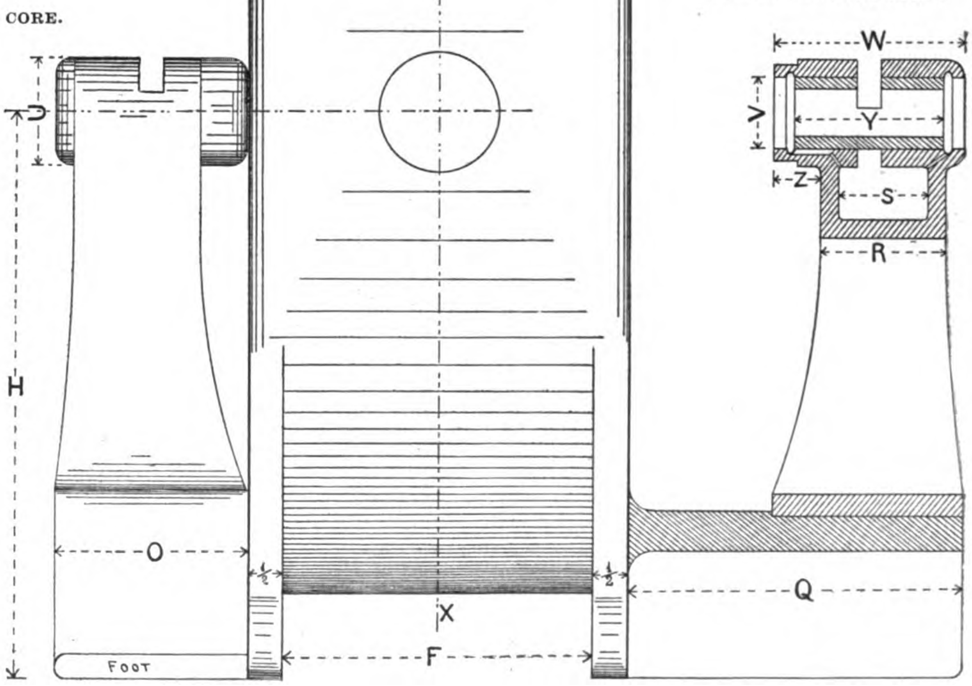


FIG. 2.—EDGE VIEW OF MAGNET FRAME AND SECTION THROUGH A PEDESTAL AND BOX.

When all the coils are wound they should be formed in pairs, two coils being placed side by side with strips of fuller board 0.01 in. thick between them, as indicated by Fig. 9, and bent to the shape shown by Fig. 10. Before bending the coils to shape, the ends must be clamped from the points *A* and *D* outward and from the points *B* and *C* inward, so as to locate the bends accurately. The distance from *A* to *B* and from *C* to *D* is 3 ins., so that the distance from *B* to *C* will be 4½ ins.

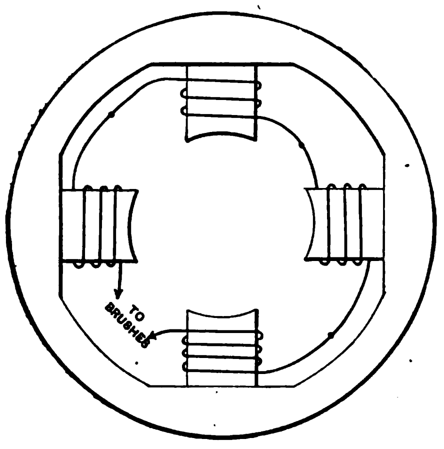


FIG. 7.—DIAGRAM OF FIELD COIL CONNECTIONS.

The sides of the coils must be pulled apart far enough to enable the coil to go into two slots on the armature core between which there are nine teeth. Then each pair of coils should be carefully wrapped with one layer of German linen tape, wound with a half lap, so that there will be two thicknesses of the tape on each side of the coils. Varnish the outer surface of the tape thoroughly, then bake the coils at a temperature of 120 to 130 degrees until they are thoroughly dried. When the coils are assembled properly on the core there will be two coils for each slot. It is for this reason that the coils are made up in pairs as above described. They must be assembled on the core so that between the two sides of each pair of coils there will be nine core teeth.

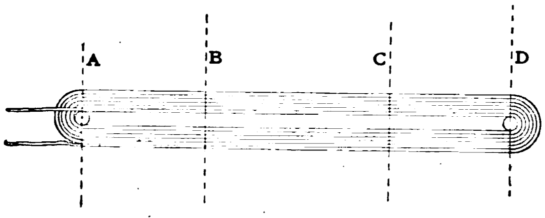


FIG. 8.—COIL BEFORE SHAPING.

When the coils are all in place they should be secured temporarily by two retaining bands of twine wrapped around the coils at each end just outside of the armature core. Then the terminals may be carried to the commutator lugs, all of the lower terminals being put in first. The terminals should be carried straight out to the commutator and care must be taken that the coils are connected up in exactly the same fashion all the way around. The terminals of each coil are connected to two neighboring commutator segments. Having put all the lower terminals in place in proper rotation, the builder can start at any convenient point with the upper terminals, being sure that the first one goes in the commutator lug immediately alongside of the lug to which the other terminal of that coil has been connected. Having started properly, the terminals can be put in, one after the other, in the rotation in which they project from the armature slots, without further testing, provided the lower terminals have all been put in in proper sequence.

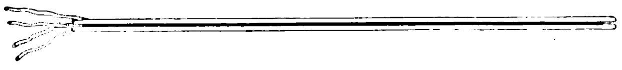


FIG. 9.

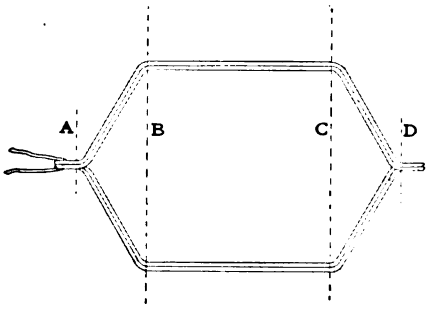


FIG. 10.—SHAPED COIL.

After the armature terminals have been soldered to the commutator lugs, binding wires of No. 19 tinned iron should be put on around the core, one binding about ½ in. from each end of the core; each binder should be about 1 in. wide, measured parallel with the shaft. The coil projections which extend out beyond the armature core proper must be bound down to the barrels which support them by means of either brass wire wound over two or three varnished layers of canvas or else heavy linen twine wound over a single layer of canvas. Only one binder will be necessary at each end of the armature winding. If there is an appreciable drop in the wiring between the dynamo and lamps, the speed should be increased until the voltage at the lamps is normal at full load, with all the rheostat out.

The principal data applying to the machine are as follows:

E.m.f at no load	120 volts
Armature speed	1400 r.p.m.
Resistance of armature winding, warm	½ ohm
Normal armature current	19¾ amp.
Normal current delivered to external circuit	18 amp.
Normal exciting current in field winding	1¾ amp.
Magnetic density in field-magnet cores	95,000
Magnetic density in air-gap	36,500
Magnetic density at roots of armature teeth	130,000
Magnetic density in armature core body	60,000

The lamp rating of the machine (35 lamps) is based on the use of 3½-watt 16-c.p. lamps. With 3.1-watt lamps the machine will, of course, maintain a correspondingly greater number.

WATER COLUMN CONNECTIONS.

BY C. W. OBERT.

There seems to be considerable diversity of opinion among engineers as to the proper method of connecting up water columns. It seems to be often assumed that, as there is to be little or no circulation through the water column connections, a small size of pipe will do as well as a larger size; and occasionally we find the connections bushed down to a smaller size of pipe than the maker of the water column tapped it for. The account of an instance of the results of such practice which recently came to the writer's notice may, however, serve for enlightenment by showing what may occur under such circumstances.

A 100 horse-power horizontal return-tubular boiler in an electric light and power plant had been running for nearly six weeks steadily, day and night, on account of some extensive repairs which were being made to the reserve boiler. The boiler was 66 ins. in diameter and 18 ft. long, with 105 3-in. tubes, and its shell was ½ in., and its heads 7/16 in. thick. It was customary, on account of the sediment from the water, to blow down the boiler at about five o'clock in the morning and about five o'clock in the evening. One morning the boiler was being blown down as usual, the fireman opening the blow-off valve and the engineer watching the water glass so as to be able to signal the fireman when to close the blow-off; but it was noticed that the water did not lower in the gauge glass. After blowing for some time, the middle gauge cock on the water column was tried, and water flowed from it freely, so it was thought that the boiler had been pumped very full previously. Beginning to fear that something was wrong, the engineer ordered the blow-off closed; but, as the water had fallen slightly since starting, he became reassured and ordered it opened again. The instant the blow-off was reopened the water in the gauge glass dropped rapidly and disappeared from view. Then the engineer perceived in an instant what had happened; the gauge glass had been indicating wrongly, and they had undoubtedly blown the boiler very low. He immediately ordered the blow-off closed, and closing the damper, had the fire covered with wet ashes. Steam was shut off from the engine and the boiler was allowed to cool.

When the steam pressure had gone down, a superficial examination was made showing that the front sheet of the boiler had bulged more than an inch at the sides over the fire and that both heads had bulged out considerably, which at once condemned the boiler for further use. In repairing it was found that about 6 ins. of water was left in the boiler and that the cause of the false gauge glass reading was that the lower water column connections had become filled with sediment. The water column casting was tapped for 1¼ in. pipe; but when connected up it had been bushed down for 1-in. pipe. The connections were rather long and the bottom connection was tapped into the boiler head among the flues near a hand-hole; the sediment had accumulated or had been previously washed into the pipe while the boiler was being cleaned.

In order to get the boiler in shape for use again, an entirely new sheet had to be put over the grates, extending entirely around the boiler, and nearly 40 tubes had to be safe-ended. The water column was re-piped with 1¼-in. pipe as it should have been in the first place, and the bottom connection was tapped into the front head just below the top row of tubes. Since then the rule has been firmly established to blow out the lower connection frequently to try its condition. The great cost of repairs and of shutting down the plant from this comparatively insignificant cause should serve as a warning to engineers to be sure that their water columns are properly piped.

EFFICIENCY OF TELEPHONE GENERATORS.

BY W. S. HENRY.

The capacity of a telephone generator is ordinarily referred to by saying that the machine "will ring through" so many ohms. This, of course, means very little, especially when nothing is stated concerning the winding and efficiency of the bell and the resistance of the line. Moreover, the efficiency and capacity of a generator are entirely different quantities. We may specify the capacity of a telephone generator by stating that it will ring a bell of a certain winding and efficiency through a certain number of ohms, or by stating that it will ring a certain number of bells of a certain winding and efficiency through a negligible or a stated resistance. Moreover, it would not be proper to compare in this way a generator designed to ring bells connected in series in the line with one designed to ring bells connected in parallel, as on a bridging line. They may both be excellent generators for the purpose intended and yet neither may be suitable or capable of doing the work of the other one.

Generators for ringing bells in series should be designed to furnish a small current and a large electromotive force; whereas generators for ringing bells bridged across a line should furnish a larger current but a smaller electromotive force than series generators. Furthermore, in testing generators for either efficiency or capacity it may make quite a difference in the results whether the resistance in the circuit outside of the bells and generator is inductive or non-inductive.

To the writer the following method of comparing the capacities of telephone generators seems to be fair and simple. Suppose we assume that an average telephone line will have a resistance of 28 ohms, which is equivalent to a metallic circuit of No. 12 E. B. B. iron wire extending one-half mile from the generator. Then select a sufficient number of good and exactly similar bells; by "similar" bells I mean bells of equal resistance and efficiency.

Bells of equal resistance have the same efficiency when the minimum current that will just ring one bell will also just ring the others. When an ordinary hand generator is used to determine the relative efficiencies of several bells, care must be taken to turn the handle of the generator at the same speed when testing the various bells, because the higher the speed the greater will be the electromotive force generated, and hence the greater the current with the same resistance. It would be much preferable to use an ammeter or current-indicator of a suitable kind to measure the strength of the current.

To compare series generators, connect in series with the generators and a non-inductive resistance of 28 ohms as many similar bells as each one will ring when turned at exactly the same ordinary speed. Then evidently the generator that will ring the most bells will have the greater capacity or output of electrical energy; not necessarily the greater efficiency, however, because although one gives a larger output it may also require much more power to turn it at the same speed at which all are supposed to be turned when tested.

Bridging generators may have their capacities compared in a similar manner, connecting all the bells in parallel, however, in this case, and preferably at the end of the non-inductive resistance of 28 ohms. This would not give exactly the same conditions as obtained in practice, where the bells would be distributed along the line, in which case the last bell on the line would be less likely to ring than the others. However, the arrangement mentioned would be fair if adhered to in all tests for the output capacity of generators.

In comparing the output capacities of telephone generators that are intended to ring only two bells, their own and one at the other end of the line, it may be sufficient to say that that one is the best which will ring the distant bell through the greatest non-inductive resistance connected in the circuit between the generator and bell. In this case the same bell should be used at the distant end of the circuit when testing the various generators, and, moreover, care should be taken to turn the various generators at the same speed.

For regular testing magnetos which are used for making continuity and open-circuit tests, it is satisfactory enough, as a rule, to say that the generator which will ring its own bell through the greatest non-inductive resistance is the best generator, as far as its output alone is concerned. Furthermore, if the generator which gave the best results in the above test was as well constructed, both electrically and mechanically, as the other generators tested, then it may be pronounced the best generator, all things considered.

The efficiency of any generator is equal to its output divided by the imput, both quantities being reduced to the same units, of course. The output of any dynamo is usually expressed in watts or kilowatts. In the case of a direct-current machine the output in watts is equal to the product of the current in amperes, flowing in the circuit external to the machine and the difference of potential in volts, across the terminals of the machine. These quantities may be measured separately by an ammeter and voltmeter, respectively, or the product may be measured by a wattmeter.

The output of an alternating-current generator is only equal to the product of the amperes and volts when the external circuit consists solely of non-inductive resistance. But telephone bells possess considerable inductance and therefore the output of a telephone generator cannot be calculated in such a simple manner. The inductance causes the current to lag behind the electromotive force to an extent which is called the "angle of lag," the cosine of which angle is numerically equal to the power factor of the circuit. In order to ascertain the true watts in such a case, it is necessary to multiply the product of the amperes and volts by the power factor. The power factor may be determined by any one of several methods; it is beyond the scope of this article, however, to explain such methods. A much easier way to measure the output is to do so directly by means of a properly designed wattmeter, of which there are several on the market. Such an instrument gives the true watts of the circuit directly, no matter what the power factor may be.

The input is equal to the mechanical power required to turn the armature. This is equal to $2 \pi r n f$; in which f is the force that causes the armature to rotate, n is the number of revolutions made by the armature per second, and r is the distance from the point of application of the force to the center of the armature shaft. If r is expressed in feet and f in pounds, the above expression gives the power in foot-pounds per second. This may readily be reduced to watts by multiplying it by 1.356. There are various methods for determining this input, and each one requires more or less special apparatus. It is a more difficult matter to accurately determine the input of a dynamo than to determine its output. Wherever the output and input have been mentioned in this article they mean the output and input of the generator when run at normal speed and at full load, that is, when ringing, say, the greatest number of bells.

Even if the efficiencies of several telephone generators are properly determined, it does not necessarily follow that the most efficient one is the best one to use, because it may not give the most suitable electromotive force, or its normal speed may be such as not to give an alternating current of the frequency most suitable for ringing the telephone bells. Hence, there are other considerations as important as the efficiency, if not more so. Moreover, the general construction of the generator and its ability to stand constant and perhaps hard usage must be given due consideration.

While it would be preferable to compare telephone generators by their efficiencies, if they come up to requirements in all other respects, nevertheless the efficiency is much more difficult to determine for small machines, such as these generators, than the mere output capacity. Hence, in practice the real efficiency of a telephone generator is very seldom, if ever, considered. If any comparative test is made by the purchasers or users it is usually to determine how many bells the generator will ring, either in series or in parallel, as the case may be, or through how many ohms it will ring one or two bells. This method would be much more satisfactory if we only had bells of standard efficiency and resistance; but these, unfortunately, we do not possess.

STRIPPED RAILWAY MOTOR ARMATURES.

BY FRANK BERRY, JR.

Among the various parts of motors found scattered about in the railway repair shop, not infrequently may be found a stripped armature. The most common of the various causes which lead to such a condition are, worn bearings, a sprung armature shaft, or loosened bolts which permit the pole-pieces they hold to rub against the armature. As soon as the bearings supporting the armature shaft become worn to any extent they should receive immediate attention; otherwise they may wear sufficiently to permit the armature to chafe against the bottom pole-pieces.

A sprung armature may be the result of loose gearing, or as is oftentimes the case, a piece of metal may break from the casting and wedge itself between the gear and pinion. To guard against sprung armature shafts due to loose gearing, the gears should be tightened up as soon as any noise from them is heard.

The bolts which hold the pole-pieces in position, especially those at the top, very often work loose and are a source of serious trouble. The writer recalls an instance where the pole-piece dropped sufficiently, owing to loose bolts, to be caught and broken by the revolving armature; the broken part puncturing a great many of the armature coils. One of the very annoying circumstances connected with stripped armatures is the tendency of the armature bands to wind themselves about the brush-holders. To guard against accidents of this kind every motor should be subjected to constant and systematic inspection.

More Long-Distance Electrical Transmission for California.—The California Power Company has taken the preliminary steps in a large water power project in the Kern canyon, 18 miles from Bakersfield, Cal., the object being to generate electricity to be transmitted to Los Angeles, a distance of 140 miles. According to expectations there will be three separate power houses, with capacities aggregating 15,000 to 18,000 horse-power.

Lessons in Practical Electricity

FUNDAMENTAL PRINCIPLES.

Electricity is referred to as a "current" and is said to "flow" through materials known as "conductors." Electricity, being imponderable, however, it is not positively known whether there is actually a flow of current or not. But the uncertainty of these expressions is of much less importance than the immense convenience afforded by their use. If one undertook to describe accurately the phenomenon commonly known as the flow of an electric current, the description would be necessarily roundabout and lengthy, as well as bewilderingly abstruse to anyone without highly scientific training. It is known that when the two ends of a conductor or system of conductors are connected to a source of electricity there is a transfer of energy throughout the conducting system; this is so nearly analogous to the flow of a current, and the results obtained are so thoroughly compatible with the notion of current flow, that the expression is sufficiently descriptive for all practical purposes.

All sources of electricity, of whatever kind, produce electrical pressure, and it is this pressure that causes the phenomenon known as current flow. This pressure or stress is termed "electromotive force," and is almost always abbreviated "e.m.f." both in speaking and writing. The student will find it helpful to adopt the assumption that all space and matter are filled with electricity in an inert state, and that in order to utilize it, an e.m.f. must be generated with which to force it into motion, and a conducting system must be provided through which this e.m.f. may force a current. The unit of electromotive force is the "volt," so named in honor of the Italian physicist, Alessandro Volta.

In flowing through a conductor, electricity behaves very much like an incompressible fluid in a full pipe; thus, no matter how large the conductor may be, no electricity can be "put in" at one end of the conductor without a similar quantity leaving the other end. The electric current is commonly measured in "amperes," this unit having been named in honor of the celebrated French scientist, André Marie Ampère. The ampere is not the unit of quantity, but of what might be termed the magnitude of the current; it is usually defined as the unit of "rate of flow," but this is somewhat confusing to a beginner. The term "strength," which is frequently used to express the value of a current, is much more expressive, and it is sufficiently descriptive, inasmuch as the work that a current of electricity can perform varies directly with its "strength" or value in amperes.

The unit of electrical quantity is the "coulomb," so called in honor of Charles Augustin de Coulomb, one of the early investigators of electrical phenomena. The quantity of electricity transmitted through a conductor is equal to the strength of the current, in amperes, multiplied by the length of time, in seconds, that it flows. Thus, if a current of 5 amperes should flow through a conductor for 10 seconds, the quantity transmitted would be 50 coulombs.

As intimated in the opening sentence of this Lesson, materials through which electricity can be made to pass are known as "conductors"; those through which it cannot be forced being called "non-conductors" and "insulating" materials. All conductors possess a property known as electrical "resistance," which restricts the strength of the current. The unit of resistance is the "ohm," and was named in honor of the German mathematician, Georg Simon Ohm, who formulated the fundamental law of current flow. This law, expressed in modern phraseology, states that the strength of a current varies inversely as the resistance of the conductor through which it flows and directly as the strength of the electromotive force which causes it to flow. Stated arithmetically this reduces to

$$\text{Amperes} = \text{Volts} \div \text{Ohms}.$$

The resistance of a conductor varies with its cross-sectional area and its length; the larger the area, the less the resistance; and the greater the length, the greater the resistance. The accompanying table gives the resistances of round conductors 1/1000 in. in diameter and 1 ft. long, of various materials, at a temperature of 32° Fahr.:

Material.	Specific Resistance.
Silver, annealed	9.57
Silver, hard	9.88
Copper, annealed	9.59
Copper, hard	9.89
Gold	12.3
Aluminum wire	15.2
Zinc, pure	32.
Iron wire (galvanized)	58.2
Steel wire (galvanized)	96.
Lead (pure)	110.
Mercury	600.
Carbon (graphite)	18,000 to 240,000
Carbon, common arc lamp	20,000 to 30,000

Power is required, of course, to force a current through a conductor. Electrical power is measured in "watts," the origin of which name will be obvious to all who are familiar with the history of the steam engine. Multiplying the strength of current by the e.m.f. which causes it, will give the power in "watts" that is being applied to the conductor. For example, if an e.m.f. of 100 volts be applied to the ends of a conductor having a resistance of 50 ohms, Ohm's law shows that a current of 2 amperes will flow through the conductor; the power or rate of work, therefore, will be 100 × 2 = 200 watts. The rate at which electrical energy is delivered to a conductor may also be ascertained by multiplying the resistance of the conductor by the square of the strength of the current flowing through it; also by dividing the square of the e.m.f. by the resistance. Thus,

$$\text{Watts} = \begin{cases} \text{Volts} \times \text{Amperes}; \\ \text{Volts}^2 \div \text{Ohms}; \\ \text{Amperes}^2 \times \text{Ohms}. \end{cases}$$

The energy delivered to a conductor is equal to the product of the power in watts and the time in seconds; or the product of the quantity in coulombs and the e.m.f. that drives the current through. The unit of electrical energy was named for James Prescott Joule, a celebrated English physicist who did notable work in establishing the doctrine of the conservation of energy; the unit of energy is, therefore, the "joule." The arithmetical relation between the joule and the other units is as follows:

$$\text{Joules} = \begin{cases} \text{Coulombs} \times \text{Volts;} \\ \text{Watts} \times \text{Seconds.} \end{cases}$$

The following example may help to make clear the inter-relationship of all the units thus far mentioned:

The ends of a 50-ohm conductor are connected to a source of e.m.f. of 100 volts steadily for one minute. (*a*) What strength of current will flow? (*b*) What *quantity* of electricity will be transmitted through the conductor? (*c*) At what rate will energy be transmitted (or converted); *i. e.*, what power will be applied? (*d*) How much energy will be transmitted (converted)?

(*a*) 100 volts ÷ 50 ohms = 2 amperes.

(*b*) 2 amperes × 60 seconds = 120 coulombs.

(*c*) 100 volts × 2 amperes = 200 watts; also, 100^2 volts ÷ 50 ohms = 200 watts; also, 2^2 amperes × 50 ohms = 200 watts.

(*d*) 100 volts × 120 coulombs = 12,000 joules; also, 200 watts × 60 seconds = 12,000 joules.

Letters on Practical Subjects

A Formula for Tool Handles.

To the Editor, American Electrician;

Sir:—On page 409 of the August number Mr. Gaston requests a formula for tool handles. He will find what he desires in the "American Machinist" of March 1, 1900. Harry Gwinner.

College Park, Md.

◆

The Standard Candle Power of Incandescent Lamps.

To the Editor, American Electrician;

Sir:—In your August issue you publish a letter from Mr. Joel Gomborow, in which he states, as the explanation of the adoption of 16 c.p. as the standard of incandescent lamp rating, that a 9-c.p. lamp would illuminate a table 6 ft. in diameter—that is, give sufficient illumination for reading purposes. This would be true if the lamp were hung in a certain position at a certain distance above the table, but if hung bulb downward, as was at first customary, it would give a very small vertical light and have to be suspended very near the table to secure the result mentioned; which position would be on the level of the eye and would not be good practice. I also call attention to the fact that the vertical light of incandescent lamps when they were first made was very small, compared to the horizontal candle power, and as they nearly all hung in a vertical position, I think very little attention was paid to the exact amount of light that was thrown in any direction in selecting a standard, except to make a lamp that would show 16 candle power in the position in which it was rated. I believe the standard of an illuminating gas jet was at that time 16 candle-power and they used this same standard in rating incandescent lamps, and also rated them in the same position. G. E. Rosenfield.

Chicago, Ill.

◆

A Problem in Mechanics.

To the Editor, American Electrician;

Sir:—Referring to the letter by Charles H. Holderrieth on "A Problem in Mechanics," which appeared in the August number of your valuable paper, it seems to me to be very plain tnat the weight of the system is not affected by centrifugal force.

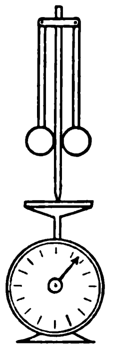
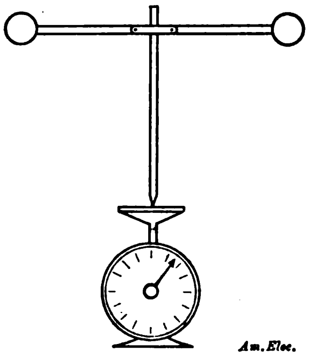


FIG. 1.



Am. Elec.

FIG. 2.

The fact that the rotation holds the balls out, which is the same as though a weightless clamp held them out, would not lessen their weight. Centrifugal force balances them in the wide circle; but, any force not acting in an opposite direction from gravity cannot affect their weight. Charles M. Green.

Conneaut, Ohio.

To the Editor, American Electrician;

Sir:—Referring to Mr. Holderrieth's question in the August number, I should say that the weight indicated by the scale will be independent of the speed of rotation of the spindle and weights. The centrifugal force is a force acting in a direction perpendicular to the axis of rotation, and it raises the weights merely by inserting, as it were, massless horizontal struts between the spindle and arms carrying the weights. The length of these arms (representing the magnitude of the centrifugal force) is proportional to the square of the r.p.m.

When the speed reaches a certain value with reference to the weight of the spheres, these imaginary struts will become equal in length to the pivoted arms, making the latter horizontal, the weights having then reached their maximum height. Increasing the speed further will not raise the weights in the least, but will only increase the tension in the arms, which may finally become large enough to rupture them. It will be seen thus that the imaginary struts inserted by the centrifugal force differ from real struts in so far as they are capable of changing the configuration of the system of spindle, arms, and weights, without adding to its weight; but they evidently cannot be expected to detract anything from the weight of the system as a whole.

Joel Gomborow.

Philadelphia, Pa.

To the Editor, American Electrician;

Sir:—In reference to Mr. Holderrieth's "Problem in Mechanics" in your August issue, I would suggest that it would come under Newton's second law of motion, which reads: "Every motion, or change of motion, is proportional to the acting force, and takes place in the direction of the straight line along which the force acts." Or, stating it differently, a force has the same effect in production motion, whether it acts upon a body at rest, or in motion, and whether it acts alone or with other forces. Mr. Holderrieth states that there is no weight borne by any mechanism not shown. Then it follows that there is no force acting to destroy gravity (weight). Gravity always remaining the same whether a body is at rest or in motion, the weight (attraction of the earth, or gravity) will be the same whether the mechanism be revolving or stationary.

Easton, Pa. H. Scott Dodson.

To the Editor, American Electrician;

Sir:—In regard to the "Problem in Mechanics" given in your August issue, I offer the following: The answer to the problem as stated would be that the scale indicated a less weight; but the hypothesis is incorrect in stating that the balls are thrown out to a horizontal position. Assuming the axis of rotation to be vertical and the center of gravity of the ball and arm to lie in the axis of symmetry, the arms could not be thrown out to a horizontal position. There would always be two forces acting on the ball, namely, the force of gravity acting vertically and the so-called centrifugal force acting horizontally. Their resultant force could never coincide with the centrifugal force, hence it could never be horizontal, and could always be resolved into its two components, one of which, the force of gravity, remains unchanged at all speeds; hence the scale would indicate the same weight.

Newcastle, Pa. J. M. Walker.

To the Editor, American Electrician;

Sir:—Referring to Mr. Chas. Holderrieth's "Problem in Mechanics," which appeared in your August number, the fallacy lies in assuming that the governor arms can ever obtain a horizontal position, as shown in Fig. 2, for any finite values of weight and speed of the governor balls. Let us consider the case of a pair of balls of finite weight, *W*, rotating at some constant finite velocity. The arms will then take up some definite position such that the vertical component of the tension in each governor arm will just balance the weight of the ball.

This is shown diagrammatically in Fig. 3 where one of the balls is shown as a free body and acted upon by two forces only,

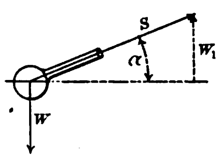


FIG. 3.

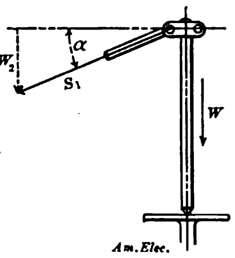


FIG. 4.

the force of gravity, W, and the tension in the rod, S, making some angle α with the horizontal.

Since the conditions are supposed to be constant and stable, the summation of the vertical components acting on this free body must be zero. That is,

$$W + W_1 = 0$$
$$W = - W_1.$$

In other words, the weight of the ball is balanced by the vertical component of the tension in the arm.

Now, taking the other part of mechanism as a free body, shown in Fig. 4, it is acted upon only by one force, S_1, the tension in the governor arms; this must equal S, because they are identical, the tension in this member being the same throughout its length; α is the same as α in Fig. 3, the two being alternate interior angles. Therefore, W_2, the vertical downward component of S_1 must be the same as W_1, which is the same as W.

Hence, it is proven that there is always a vertical downward component of force equal to the weight of the governor balls, which acts upon the scale pan no matter what position or speed the balls may have. The angle, α, may have any value from 90° to 0°, but in order for it to be zero the velocity of the balls would have to be infinite or their weight infinitely small, or both.

J. C. Brocksmith.

Chicago, Ill.

To the Editor, American Electrician;

Sir:—In regard to the problem in mechanics which appeared in your August number, I would like to submit the following simple solution: Considering any instant when the arms are in a given position, making an angle of Φ with the vertical, we have three forces at work upon B; the tension, t, on the rod, the weight, w, and the centrifugal force, f. "When three concurring forces are in equilibrium they are respectively in the same proportion as the sines of the angles included between the other two." Thus:

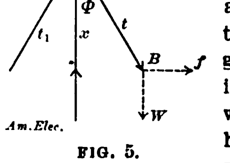


FIG. 5.

$$\frac{t}{\sin wBf} = \frac{w}{\sin tBf} \text{ or } t = \frac{-w}{\cos \Phi} \,..\,(1)$$

also

$$\frac{x}{\sin tAt_1} = \frac{t}{\sin t_1Ax} \text{ or } \frac{x}{\sin 2\Phi} = \frac{t}{\sin \Phi}$$

and

$$\frac{x}{2 \cos \Phi} = t \,............\, (2)$$

Since (1) and (2) are both equal to t,

$$\frac{-w}{\cos \Phi} = \frac{x}{2 \cos \Phi} \text{ or } x = -2w.$$

Therefore, the tension upon x is $-2w$, which shows the compression or pressure upon the scale pan to be $2w$, or twice the weight of one ball, independent of the position of B. If we have t horizontal we would have $t =$ infinity, which shows we can never make $\Phi = 90$.

Dover, N. J. Edgar D. Tillyer.

◆

Another Motive Wonder

To the Editor, American Electrician;

Sir:—Enclosed I send you a clipping from a daily paper describing a new steam engine which beats anything I ever heard of. As the illustration shows, there is not a single valve on the engine, and the boiler is merely a continuation of the cylinder. While the construction of the machine is easy enough to understand, it is not quite so evident that it will run. The inventor states that the central idea of his engine is the recondensation of steam, so that the water in the boiler may be used over and over again. I always thought that Papin and all the old-timers used to condense the steam that they used, but probably steam has never been condensed in Des Moines before. The idea of a loosely fitting piston also staggers me; I have always been in the habit of fitting pistons as nearly steam-tight as possible, but I see that I must have been on the wrong track. Hereafter, I think I will take out the piston altogether and get even better economy than Mr. Kessler. It would also be interesting to watch the steam condense in the upper part of the cylinder while water is being evaporated in the lower part. The inventor lays great stress upon a steam cushion between the piston and the cylinder walls. We poor old fogies have always been getting it between the piston and the cylinder heads.

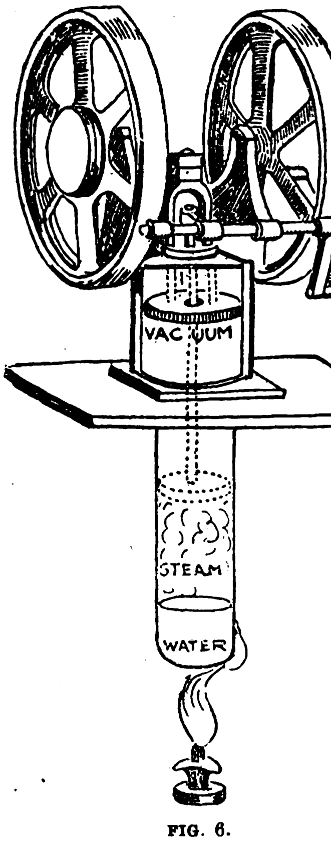


FIG. 6.

A single-acting engine with no dead center! Next!

A. A. Deighton.

Philadelphia, Pa.

The illustration to which Mr. Deighton refers is reproduced herewith, and the description of the engine, which was "invented" by a Mr. Kessler, of Des Moines, is as follows:

"The central idea of the Kessler invention is the recondensation of the steam automatically, so that the water in the boiler may be used over and over again.

"Operating in this boiler is a long hollow piston, lacking about one thirty-second of an inch of fitting to the sides of the boiler, thus leaving room for a steam cushion all the way around it, and also making it possible for the condensed steam to run down the sides. A rod connected through this piston passes up through the center of another piston, which operates in a vacuum cylinder above the boiler, and is geared direct to the flywheels.

"The upper piston fits absolutely airtight in the vacuum cylinder and is geared to the shaft in the usual crank manner. As the steam piston is forced upward it pushes the upper piston up, leaving a vacuum, which draws it back again, thus giving, in addition to the steam power of from 45 to 60 pounds pressure, the additional 15 pounds pressure of the atmosphere.

"One of the great advantages claimed for the invention is that, in view of the fact that these two pistons are connected directly to the machinery, and there being a great difference in the length of their stroke, the new engine dispenses entirely with the 'dead center' principle of all other engines, as one of the pistons begins work before the other ceases.

"Surrounding the vacuum cylinder is a jacket containing water, and which prevents the heat from the friction of the air-tight piston from expanding the metal and wasting any power. It also operates to keep the upper end of the boiler cool and assists in the condensation of the steam, which trickles down to the lower end of the boiler, where it immediately becomes steam again, and is used indefinitely. There is no vent, exhaust or escape to the Kessler engine. No steam is wasted and only a small quantity of water is used to furnish steam, for the reason that it is condensed and used again.

"Mr. Kessler asserts that his invention will reduce the weight of locomotives and automobiles by making it possible to provide them with engines which will occupy only one-third of the space taken up by those now in use, and that it will supplant windmills as pumping agents and increase the speed of submarine boats one-third."

The absolute absurdity of the design and the claims made for it, as well as the inoperativeness of the machine, will be evident at a glance to anyone at all familiar with the principles of steam-engine operation.

Electrical Catechism

632. What is an electrolyte?

Liquids may be classified into three divisions: those that do not conduct electricity at all, such as oils; those that conduct electricity without any chemical effects, such as mercury and other metals in liquid form that act like solid metals; and those that are decomposed by the passage of current. Liquids of the third class are called electrolytes.

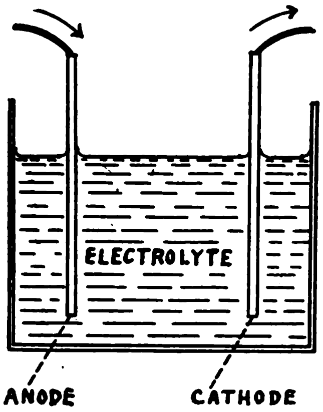


FIG. 1.—ELECTROLYTIC CELL.

633. What is an electrode?

An electrode is a name for the solid conductors which lead the current to and from the electrolyte. The anode, sometimes thought of as "in-ode," is the plate at which the current enters the liquid, being the positive terminal. The cathode is the plate at which the current leaves, being the negative terminal.

634. How much work is required to send current through an electrolyte?

The work consists principally of three parts, although there may be other sources of small losses when the electrolyte is not of uniform density. Part of the work appears as heat, corresponding to the resistance loss in a metallic conductor, being equal to the product of current by the true resistance of the electrolyte. A second loss occurs at the surfaces of the electrodes where the molecules are rearranging themselves, a process called "sweeping" which represents an actual loss; the work lost in sweeping increases very rapidly for a few minutes when the current first begins to pass, and then is proportional to the strength of the current. The third part of the work is that done in effecting the chemical changes in the electrolyte, and is strictly proportional to the current; the chemical work causes an e.m.f. which is independent of the strength of the current and depends upon the chemical changes that occur; when this e.m.f. is in a direction to increase the current, the electrolytic cell becomes a battery; when it tends to reduce the current, it is called a counter-electromotive force.

635. What is meant by polarization in an electrolyte?

The polarization is the cause of the counter e.m.f. just mentioned. It may be transient, so that it disappears when the current ceases, or it may be permanent and be capable of causing a current to flow after the former main e.m.f. is removed. The most striking example is the storage battery which is "charged" by the current from some other source and later becomes itself a secondary source of current.

636. Does polarization always occur when current passes through an electrolyte?

Polarization always occurs when there is any net chemical work done. When both electrodes are of the same metal and the electrolyte is a "salt" or compound of that same metal, the current simply transfers metal from one plate to the other; there is no net chemical work done and no polarization occurs. This fact is the basis of the Edison chemical meter and some other voltameters.

637. Is polarization a desirable phenomenon?

In many instances it is undesirable, in others it is the foundation upon which the application of electricity is made. In the battery or chemical cell for generating electricity one polarization causes the e.m.f., while another may introduce an undesirable resistance. Polarization is closely identified with most of the electrochemical processes of manufacture.

638. How can one tell which is the positive and which the negative terminal of a battery?

In most cells the electrodes are of different metals, and only one is dissolved into the solution. The metal which is subject to the more vigorous chemical action may be considered as the fuel that supplies the energy, and it is called the positive plate. But it is always found that the metal which is the more active chemically is electronegative to the other. So it comes about that the positive plate constitutes the negative terminal of the cell, and the negative plate is the positive terminal of the cell. Thus, zinc is generally used for the positive plate in cells, and the zinc is generally the negative terminal of the cells. The substance not destroyed is the positive terminal of the cell.

639. How many kinds of batteries are there?

Batteries are classified as primary and secondary, as noted already. Primary batteries are further divided into "open circuit" and "closed circuit" batteries. They may also be divided into three classes, accordingly as the depolarizer is mechanical, chemical or electro-chemical.

640. What is meant by an open circuit battery?

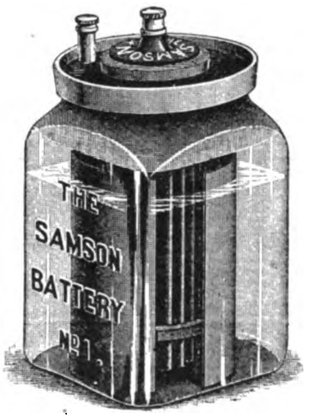
An open circuit battery is one that is suited for only intermittent work, such as operating door bells and similar devices. Such cells polarize quickly when in operation, so that their resistance rapidly increases, and diminishes the current after a few minutes. Such cells recover after a time as the polarization gradually disappears.

641. What is meant by the polarization of a battery?

When the cell is generating current, the metal dissolved from the positive plate combines with the electrolyte, and forms with it a new compound. Usually the dissolved metal displaces hydrogen gas, which appears in the form of bubbles on the surface of the negative plate. These bubbles diminish the amount of surface of plate in contact with the liquid, and so increase the resistance of the cell, and reduce the current. The hydrogen bubbles are strongly electro-positive, and set up an opposing e.m.f. which further reduces the current.

642. What are examples of open circuit batteries?

The cells using carbon and zinc for electrodes usually polarize in a short time. The electrolyte is usually a solution of sal ammoniac (ammonium chloride) in water, although other salts are sometimes used. The larger the amount of surface on the carbon electrode, the longer will the cell deliver current without polarizing. The larger the surface of carbon and zinc, and the closer they are together, the less will be the internal resistance of the cell and the more current it will deliver. Excellent forms of sal ammoniac cells are shown in Figs. 2 and 3. Some have a depolarizing substance in connection with the carbon, while others depend on the large surface and the slow removal of the polarizing gases.


THE SAMSON BATTERY Nº1.

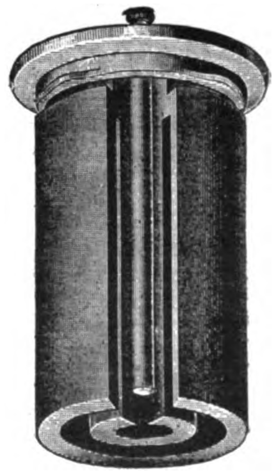


FIG. 2.—SAL AMMONIAC CELLS.—FIG. 3.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

What is the difference between alternations and cycles? C. J. G.

An alternation is one-half of a complete alternating-current wave; when the second half of the wave is completed the current has passed through one cycle.

What is meant by the term ampere-feet? J. A.

The product of the amperes of current in a conductor by its length in feet. It is used in the emperic calculations of dynamo and motor construction.

Why do transformers and current regulators on alternating-current circuits make a buzzing or humming noise? W. J. C.

The laminations of the core are put into vibration by the rapid alternations of magnetism due to the alternating current.

How can I prevent a sulphuric acid battery cell from polarizing? W. T. J.

If it is a single fluid cell you cannot prevent polarization. Put the copper electrode in a porous cup, together with a solution of either sulphate of copper or bichromate of potash.

What is the ratio between the resistance of the field winding and that of the armature winding of a series-wound motor? F. S.

The ratio varies for different designs and sizes of machines; there is no one ratio that applies to all machines. The controlling factor is the heating of the windings.

Why must a Nernst lamp be heated before it will light? A. S. J.

Because the glower rod is of such high resistance when it is cold that it is practically a non-conductor; when warm its resistance is so reduced that it becomes a conductor, although a comparatively poor one.

How many lines of force per square inch are usually employed in dynamo field magnets? (2). What is meant by the knee of a magnetic curve? G. B.

From 90,000 to 100,000 in wrought iron; from 80,000 to 92,000 in soft cast-steel, and from 35,000 to 50,000 in cast-iron. (2). It is the point on the curve where the magnetization ceases to increase in direct proportion to an increase in the exciting force.

What is meant by the "teaser system" of motor control? A. J. L.

This is a system in which three (or more) circuit wires are run from the source of current to the motors, the voltage between each pair of circuit wires being different, so that the motors can be operated at different speeds by connecting them to different pairs of circuit wires.

How can I find what the power factor of a circuit is? J. T. M.

Connect a voltmeter, ammeter and wattmeter to the circuit in the usual manner and take the readings of all three simultaneously. Multiply the ammeter and voltmeter readings together and divide the wattmeter reading by their product; the result will be the power factor of the circuit.

Can alternating and direct current be sent over the same line at the same time? (2). Why are hollow carbons used in arc lamps? (3). Are inductor alternators as efficient as the other type with collector rings and brushes? F. W. Q.

Yes; but such an arrangement has not yet been reduced to a commercial basis. (2). For the same reason that cored carbons are used; to steady the arc. (3). Yes, when properly designed.

Can the ratio between the primary and secondary voltages of an induction coil be predetermined? (2). What is the function of the vibrator? B. C. C.

No. (2). To convert the steady direct current supplied by the battery into intermittent or pulsating current. If a steady current were delivered to the primary winding there would be no effect at the secondary end; it is the alternate magnetization and demagnetization of the core that induces the secondary e.m.f.

How many 16-c.p. lamps can be considered safe in a single circuit of a three-wire system? (2). Can all three wires be drawn in a single conduit tube? W. F.

There is no limit to the number of lamps that can be connected to a single circuit, except the heating limit of the wire. With wire large enough to prevent overheating any number of lamps can be connected in one circuit. (2). Yes; this method is preferable, so that alternating current may be used, if desired, without making any change in the wiring.

Please give instructions for making an induction coil to give a ¾-inch spark, together with a condenser. J. L. M.

Make the core ¾ in. in diameter and 6 ins. long. The primary coil should be of No. 15 wire wound in 3 layers. The secondary coil should consist of 1 lb. of No. 36 double silk-covered wire. The primary and secondary coils should be wound to a length of 5 ins. only. The condenser should consist of 40 sheets of tinfoil 6 x 4 ins. between 60 sheets of thin bond paper 5 x 8 ins.

Why does the steam pressure fluctuate more in a water-tube boiler than in a horizontal shell boiler? (2). What is the gridiron valve-gear? G. L.

The water-tube boiler is more sensitive to the influence of the fire, because a much larger proportion of the total body of water is in direct contact with the heating surface. Therefore, any fluctuation in the firing will show immediately on the steam gauge; widely fluctuating demands for steam will also affect the pressure because the steam space is comparatively small. (2). There is no gridiron valve-gear. A gridiron valve is a modified form of slide valve which reciprocates over a multiple-ported seat and is slotted to correspond with the ports.

How can I raise the secondary voltage of a transformer located so far from the station that the line drop reduces the voltage too much at full load? W. J. C.

A better plan than changing the voltage of the transformer would be to put in a boosting transformer or else reinforce the feeder. The secondary voltage can be increased, however, by either adding a few turns to the secondary winding or taking off a few from the primary. This method is objectionable in that it gives too high a voltage at very light loads.

Why are two trolley wires used on a single-track railway? (2). Can a series-wound dynamo be used for incandescent lighting service with the lamps connected in parallel? W. P.

More for convenience than anything else. The use of the two trolley wires obviates the use of switches at turn-outs; the cross-section of the feed wires is reduced to compensate for the additional cross-section of the extra trolley wire. (2). No; reducing the load would reduce the field excitation and the voltage would drop below that required for maintaining the lamps at candle-power. At very light loads the dynamo would not excite because of the high resistance of the load.

Can a shunt-wound dynamo be used for arc lighting with the lamps connected in series? (2). Why do the brushes of a large generator cover two and sometimes three segments of the commutator? (3). With alternating current in the primary of a transformer, is the secondary current direct or alternating? W. P.

Yes; shunt windings on high-potential machines, however, are prohibitively expensive and unnecessary; the machines operate as well or better with series windings. (2). In order to provide sufficient contact surface between the brush and the commutator to prevent over-heating. Also to provide the proper time element for reversing the current in the short-circuited coils connected to the segments beneath the brush. (3). Alternating, of course.

Why are the crank pins on a cross-compound engine set 90 degrees apart? (2). Does a triple-expansion engine run more smoothly than a compound? (3). Which is the most economical type of engine? (4). What are the advantages of high piston speed? (5). Under what class of engines does the Diesel motor come? T. S. H.

Chiefly in order to divide up the crank impulses and obtain four per revolution instead of two. An incidental advantage is that the engine can be started up from standstill regardless of the position of either crank. (2). The number of expansions has nothing to do with the smoothness of running. The shaft of a three-crank engine has a more even angular velocity than that of a two-crank engine, for the reason that there are six impulses per revolution instead of four. (3). This depends upon the character of service and the conditions under which the engine operates. Under proper conditions and in large sizes a triple-expansion engine is more efficient than a compound. The question cannot be answered here in full. (4). A reduction in the size of the engine per unit of output and also a reduction in cylinder condensation. (5). It is an internal combustion engine.

SOLENOIDAL ELECTRIC ELEVATOR CONTROLLER AT THE EXPOSITION.

There is in operation in Machinery Hall at the Pan-American Exposition an interesting elevator plant, the equipment of which includes the Cutler-Hammer solenoid type of controller, illustrated by Fig. 1 herewith. The controller is operated by means of a small switch, located in the elevator car, of course, and represented by Fig. 2. This latter switch controls the current delivered to the solenoid of the main controller; this current is said not to exceed one-quarter ampere. The main controller is built in box form, as the engraving indicates, having two long marble panels on each side and two smaller panels at each end. The operation of the controller is as follows:

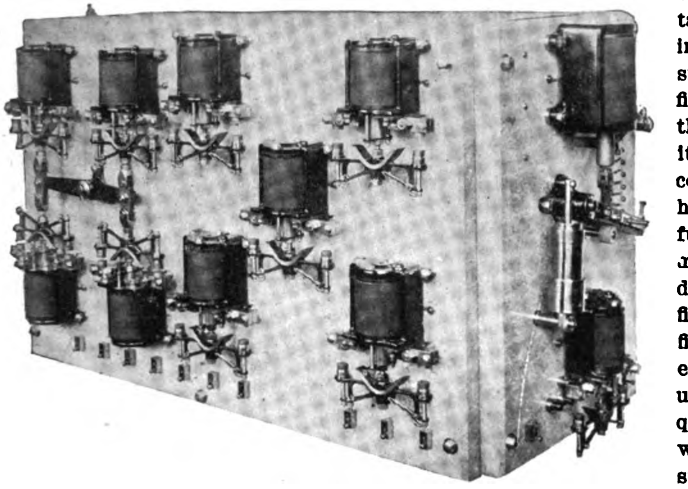


FIG. 1.—ELECTRIC ELEVATOR CONTROLLER.

When the car switch is in its central position it is held there by means of a spring latch and the circuits of all the solenoids on the controller are open. Pressing a push button on the end of the handle releases the latch and the lever can then be moved, say, to the first notch on the left of the center. This will energize the "up" solenoids of the reversing switch shown on the left-hand side of the large panel in Fig. 1. This particular style of reversing switch has four solenoids which are energized in pairs, located diagonally opposite each other. The energizing of the "up" solenoids closes the armature circuit and the shunt field circuit in the proper relation to cause the car to ascend when current is admitted to the motor. A further movement of the car switch energizes two independent solenoid-controlled switches which connect the motor terminals to the line, and cause the motor to start. One of these main solenoid-controlled switches is shown at the bottom of the right-hand panel in Fig. 1. The panel at the opposite end of the controller looks precisely the same as the end shown in the cut.

As soon as the motor starts, the solenoid shown at the top of the end panel attracts its plunger, which is retarded by the dash-pot shown, so that the lever moves slowly over a series of contacts. This action causes the successive energizing of the five solenoid-controlled switches shown on the large panel. These switches are therefore closed one after the other, cutting out sections of a series field winding, and thereby gradually bringing the motor up to full speed. It should be noted that no external resistance is used in this case. The series winding on the motor has sufficient ohmic resistance to keep the first flow of current within the rated capacity of the motor, in fact this first flow of current is generally less than the running current.

Moving the car switch as far as it will go to the left energizes another solenoid which moves a dash-pot retarded lever slowly over a set of contact segments, thereby introducing external resistance into the shunt field circuit and causing the motor to increase its speed about 30 per cent. This arrangement has several valuable functions. First, the motor always starts under an intensely strong field; second, the shunt field cannot be weakened by the attendant until the motor has acquired its normal speed with full shunt field strength; third, it enables the motor to lift heavy loads at slow speeds and lighter loads at high speed; fourth, in stopping the motor the controller first automatically strengthens the shunt field, thereby decreasing the speed of the motor before the mechanical brake is put into action; fifth, in stopping the car, current is returned to the lines, which will drive the wattmeter backward and credit the consumer with the current thus returned; sixth, the motor, being capable of operating with a wide variation of field strength and no external resistance in the armature circuit, can take its supply from a lighting circuit without interfering with the steadiness of incandescent lamps on the circuit.

Another interesting feature of this controller is the time-limit overload attachment. This device is actuated by a very small electromagnet 2 ins. long, wound with coarse wire and connected in the main line so as to receive at its admission terminal all the current used by the motor. The current branches at this terminal, four-fifths of it passing through some thin iron strips and the other fifth going through the coarse wire on the magnet. The result is that when the motor receives a slightly abnormal current the overload relay will not act, but if this abnormal current lasts for three or four seconds it will heat up the iron strips, thereby increasing the resistance of said strips and causing more current to go through the coarse wire on the magnet, which will then have sufficient strength to attract its armature and thereby break the motor circuit.

When the armature of the overload relay is attracted it opens a very small switch which carries about 1/10 ampere and controls the winding of the solenoid shown at the bottom of the right-hand panel in Fig. 1. The de-energizing of this solenoid allows its switch to drop, which opens the motor circuit, drawing an arc between carbon brushes, which arc is promptly disrupted by means of powerful blow-out magnets whose poles can be seen projecting through the marble in the engraving. It should be noticed that nothing else happens to the controller when the overload relay works. As soon as the operator returns the lever of the car switch to the "stop" position, the controller is ready to operate again, as all the solenoids drop their switches and of course the overload relay magnet drops its armature and everything is ready for another start. In case too heavy a load is on the car, the operator can keep on trying to start and causing the overload relay to act until he finds he cannot start the car, when he can then remove some of the load. This attachment is tested in the factory by blocking the motor so that it cannot turn and then admitting current to it. Several other safety features are used which are not shown in the cut. These consist briefly of an independent circuit breaker controlled by a push button in the car; limit switches for slowing down the motor and finally stopping it as the car approaches its upper and lower limits of travel; a "slack cable" switch, and a compound-wound solenoid for controlling the mechanical brake.

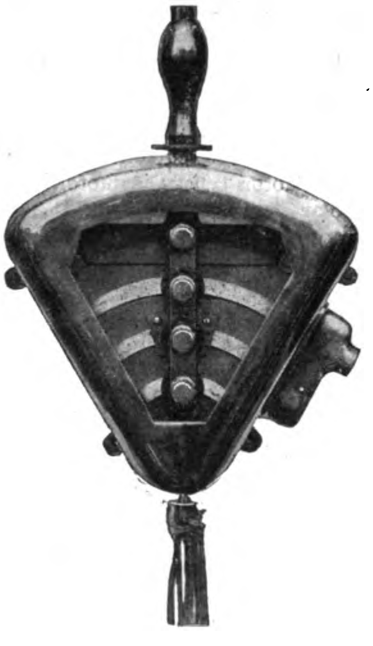


FIG. 2.—ELEVATOR SWITCH.

The switch in the car is provided with a hub spring which tends to keep the handle in the central position, so that the car will be automatically stopped as soon as the operator lets go of the switch handle.

This particular controller is mounted on top of a Crocker-Wheeler motor and connected with elevator mechanism built by the Howard Iron Works of Buffalo. It can be seen in operation in the northwest corner of Machinery Hall.

HOMOPOLAR MOTOR METER.

The homopolar or so-called unipolar form of dynamo-electric machine has been a fascinating subject for the exercise of ingenuity ever since its principle was first made public, but until recently all efforts to utilize the alluring feature of "direct current without a commutator" have been confined to machines of heavy output, and nearly all of these ended their career in the experimental stage. A shining exception to the trend and results of previous attempts is found in the Halsey direct-current meter, which is of the motor type, the motor being a homopolar or unipolar machine, with mercury-cap contacts. This meter has been developed to its commercial form during the last six years by Mr. Edward S. Halsey; the first form, patented in 1899, is shown in partial section by Fig. 1. The armature is a vertical cylinder of copper carried at its upper end by a head or spider on a shaft which holds it centrally in a cylindrical slot in a body of cement into which are molded the long pole-pieces, 4 and 5. These pole-pieces have convex and concave faces respectively, corresponding to the two walls of the annular slot or mercury chamber of which they form a part, and concentrate the total field of the surrounding magnet, 1, at the small section of the cylinder or armature, which cuts the lines of force throughout nearly its entire length, but along only a narrow section in width.

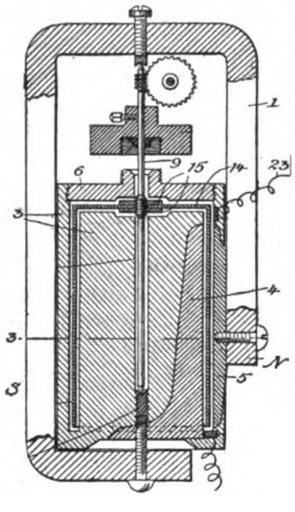


FIG. 1.—SECTION OF METER WITH CYLINDRICAL ARMATURE.

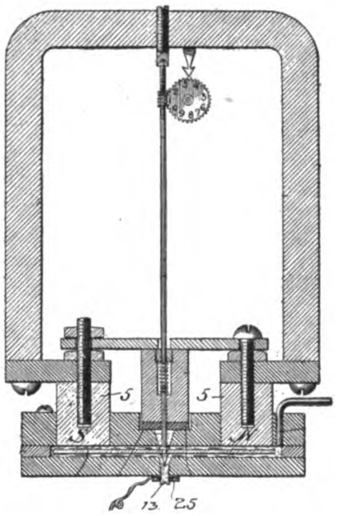


FIG. 2.—SECTION OF METER WITH FLAT DISC ARMATURE.

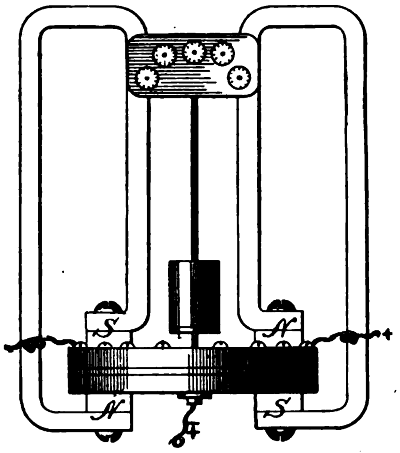


FIG. 3.—METER HAVING INDEPENDENT MAGNETS.

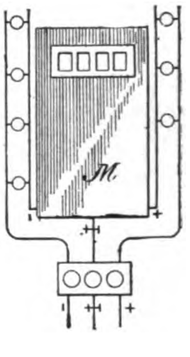


FIG. 6.—METHOD OF CONNECTING THREE-WIRE METER.

The annular slot which forms the interior cavity of the cement body is filled with mercury up and into a neck around the shaft, thus entirely submerging the armature. The circuit leads at the top and bottom of the slot are molded into the cement body when formed, and conduct the current to and from the armature, through the medium of the mercury, so that the current traverses the armature the entire length of the concentrated field. This form of magnetic circuit gives a very powerful torque for a unipolar motor; at the same time, the bearing friction is said to be practically negligible as compared with a jeweled meter, on account of the absence of weight or pressure on the bearings. The floated copper armature being considerably lighter than the mercury, and the buoyancy being just compensated for by a circular ballast weight fixed on the shaft in the case of a 25-ampere meter, the required starting torque is very small; it is stated that it will start on considerably less than 1/20 of an ampere, and that a 25-ampere meter is but 10 per cent slow on ¼ ampere or 1 per cent of its full load, about 5 per cent slow on ½ ampere, 1 per cent slow on one ampere and from this to full load there is not an error of over 1 per cent at any point.

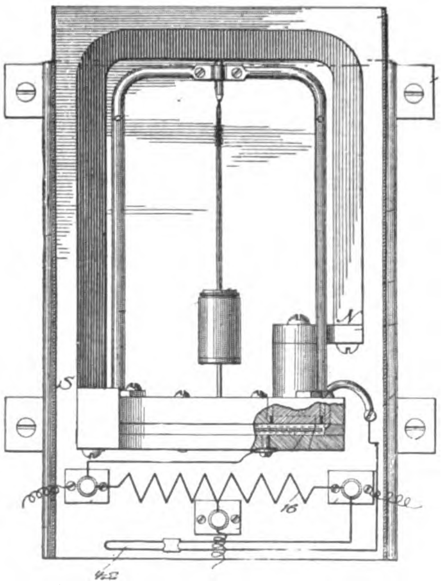


FIG. 4.—THREE-WIRE SINGLE-FIELD METER.

The accompanying illustrations refer to various forms of mercury meters patented by Mr. Halsey. Fig. 2 is a sectional view of a form in which the armature is a plain flat copper disc enclosed in a receptacle formed of an iron bottom disc, and a fiber top disc, separated by a ring washer of fiber. The two pole pieces, *N* and *S*, are round studs of soft iron pressed through holes punched in the heavy fiber tops and are joined to the two poles of the magnet by means of the two soft iron stampings. This engraving shows the ballast weight slid down on the shaft so as to compress a soft rubber gasket, cemented to it, thus sealing the meter mercury-tight so that it can be inverted and transported in any position. The weight is held down by a stamped yoke; which is carried by a screw at the center of one of the pole-pieces and is swung around across the weight and engages a screw in the other pole-piece by a notch in its side, permitting it to swing into place beneath an adjusting thumb nut. It will be noted that the current is conducted by the leads, 13 (the center step-bearing acting as one lead), so that in this case the current does not pass both fields; it might, however, be made to do so, as in Fig. 3, thus developing double the torque.

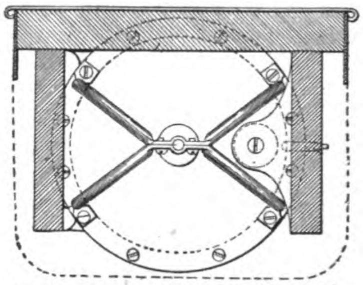


FIG. 5.—SECTION THROUGH FIG. 4.

In Fig. 3, the arrangement and relation of the fields and disc armature are practically the same as in Fig. 2, but the bottom plate of the receptacle, instead of being of iron is of fiber, having two round iron studs or pole-pieces through it, thus making it almost an exact counterpart of the top plate of the receptacle, the upper pole-pieces coming exactly above the lower pole-pieces. The two independent magnets shown maintain through their north and south pole-pieces independent fields at opposite edges of the disc armature enclosed in the mercury receptacle, so that current led to it by the positive electrode may pass across both fields in traversing the radius of the disc and pass through out at the negative lead at the opposite side; or a portion or all of the current may pass out through the center bearing, which constitutes the neutral lead, after having passed across one field only, thereby developing but a fraction or one-half the torque and velocity, and thus being adapted to measurement of current on a three-wire system when connected into circuit as shown in Fig. 6.

The meter illustrated by Fig. 4 is of still a different form, and one which Mr. Halsey has finally adopted as being the simplest, cheapest and most practical, and which is about ready for the market. In the illustration given this form of meter is shown with a fraction of the mercury chamber broken away to give an idea of the interior arrangement, and Fig. 5 is a horizontal cross-section through the upper part of Fig. 4, looking down; the position of the removable aluminum cover is indicated by the dotted lines. In this form the iron bottom plate has a lug the width of the magnet, cast on the left-hand side, and rising above the fiber top disc, so as to join the *S* end of the magnet; this makes the bottom plate the south pole, and requires but one pole-piece through the fiber top, which pole-piece is joined to the *N* end of the magnet through the medium of the soft-iron stamping.

In this meter, the current traverses the disc for a distance of but little over an inch, entering the bath by the upper lead and passing out through the bottom lead, through the iron plate. It will be seen that this armature circuit, which includes the adjustable loop, 42, is shunted by the resistance, 16, so that the total current does not pass through the armature. A third central binding post adapts the meter for connection to a three-wire circuit, as shown by Fig. 6. This three-wire feature, though simple, is claimed to be of exceptional value.

The frame for supporting the dial and the top bearing for the shaft, consists of two aluminum wickets. The cover joints are all double-seamed together, no solder being used. When the cover is pushed back its edges spring in between the two head rolls, thus making it thoroughly dust and bug proof without the need of felt or other packing. The lead wire openings are also dust-proof as they end dead in the backboard. Either a common pointer dial or a disappearing-figure counting mechanism may be used, but at present all meters are fitted with the common pointer dial.

In one of his patents Mr. Halsey covers a differential driving mechanism for the recording cylinders, by which the cylinders are always driven in a forward direction by two reciprocating arms working in alternation, regardless of the direction of the rotation of the motor spindle and worm wheel, so that no care need be taken as to the direction of the service to the meter. The meter is calibrated to read in watt-hours on constant-potential circuits of any potential from 100 to 240 volts, or in ampere-hours for arc lights and for storage-battery work.

The magnets of the meter consist of a steel casting made to a special specification and treated by a special process. Another interesting feature of this meter is the fact that the shunting or reduction of the lines of force of the field does not materially change the speed, as the same field which determines the torque acts as the magnetic brake for the meter. As there is no potential winding, the meter cannot creep or turn while the load is off, and there is no loss due to shunt current; short-circuits cannot weaken the magnet and there is practically no drop across the meter terminals at full load.

Simple and convenient means are provided for leveling, but on account of the mercury flotation, being out of true does not affect the running appreciably, even on the smallest loads. It has been found that the layer of scum which forms at once on the surface of the mercury thoroughly protects it against further oxidization or sloughing. The speed of the meter may be regulated by simply turning a lever or index finger on the bottom of the mercury chamber. It is small and compact—a 30-ampere meter being only 8½ ins. high by 5½ ins. wide and 4¾ ins. deep.

THREE-WIRE SECONDARY DISTRIBUTION FROM TRANSFORMERS.

The past two or three years have witnessed the very general introduction of the 110-220 volt alternating-current three-wire system. Not only is this being used exclusively by numerous plants recently built, but a considerable number of older stations have remodelled their lines to conform to this modern practice. The advantages of this method of secondary distribution, using large transformers situated at suitable points, are so well known as to require no discussion. A difficulty that has developed in working the ordinary core-type transformer on three-wire mains is a serious disturbance of the regulating property of the transformer when the load becomes unbalanced. As heretofore constructed the core-type transformer was wound with one primary coil and one secondary coil on each leg of the core, there being thus two primary coils and two secondary coils. When connected to a three-wire system, one of the secondary coils is connected between the neutral and one outer wire and the other coil between the neutral and the other outer wire of the circuit. If one side of the system is loaded and the other side unloaded, the transformer therefore is supplying current from one secondary coil and no current from the other one.

The disturbance which this inflicts upon the regulation of the transformer is so disastrous as to practically prohibit the use of such a transformer for three-wire service. Taking the extreme case where the one side is fully loaded and the other side unloaded, it has been observed that the voltage on the loaded side dropped from 100 volts down to 80 or 85 volts while the potential on the unloaded side rose from 100 volts up to 115 or 120 volts. This, of course, is the extreme effect, and as the regulation becomes normal when the two sides carry equal loads, the regulation will vary from normal to the prohibitive condition mentioned.,

It was found that the effect was caused by the excess of current in the one coil over the other apparently causing a leakage of the magnetic lines of force. The solution evidently was to wind the coils of the transformer in such a manner that the disturbing effect of the excess current in one side should have absolutely no effect upon the distribution of the magnetic lines which thread the assembled coils. In the many experiments made by the Pittsburg Transformer Company with relation to this problem, some curious effects were brought out, one of which may be of general interest. It was observed with a transformer having the common style of winding mentioned above that no unbalancing effect was to be detected so long as the transformer was not mounted in its cast-iron case; another transformer wound in precisely the same manner, but mounted in the case, showed the unbalancing effect markedly. This second transformer was then removed from the casing and again tested, with the result that it failed to show the unbalanced effect looked for. It was then evident that the cast-iron case surrounding the transformer was responsible for at least a portion of the magnetic leakage which produced the distorted regulation.

As the result of the experiments referred to, the Pittsburg Transformer Company has adopted the expedient of dividing one set of the transformer windings (either the primary or the secondary) into two groups connected in parallel between the terminals which issue from the case. For example, if it is the primary winding that is sub-divided, there are usually four separate coils, two on each leg, and the two on one leg are connected either in series or in parallel, according to the voltage of the circuit, the two coils on the opposite leg being connected up similarly; the two groups are connected in parallel to the main circuit. This is the simpler arrangement, but the patent covering the invention also covers a similar sub-division of the secondary coils, there being two groups of coils on each side of the neutral wire, one group on one leg and the other on the other leg of the transformer. Such a distributed winding absolutely prevents any difference in the counter e.m.f. at the terminals of each group of coils, except that due to resistance drop. This winding has been carefully tested under varying conditions, with the result which theory indicates should be obtained—no disturbance in regulation beyond that due to the resistance drop in the windings.

New Apparatus and Appliances

NON-BRITTLE DIAGONAL CUTTING PLYERS.

The Smith & Hemenway Company, of New York, has added to its line of construction tools a tough, non-brittle, diagonal plyer for electric-light and telephone construction purposes, which tool is known as No. 342 Swedish diagonal plyer, and is illustrated by Fig. 1. The points of superiority claimed for this plyer are that the jaws are perfectly parallel and will cut the finest insulation, while at the same time they are stiff enough to cut any kind of hardened copper wire or light steel or iron wire.

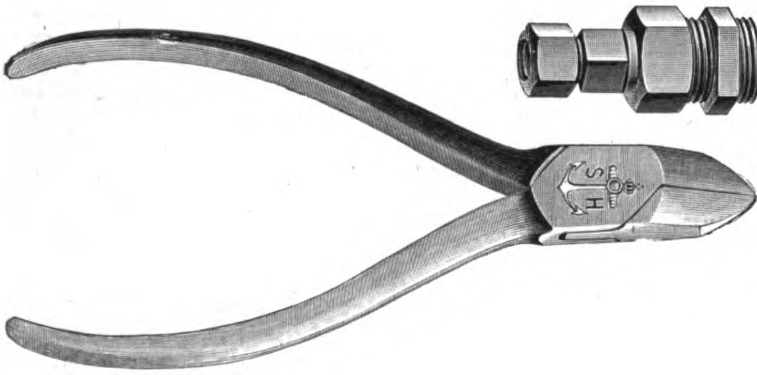


FIG. 1 —DIAGONAL CUTTING PLYERS.

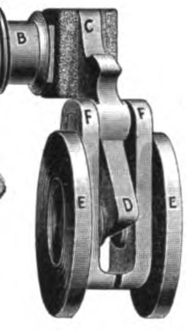


FIG. 3.

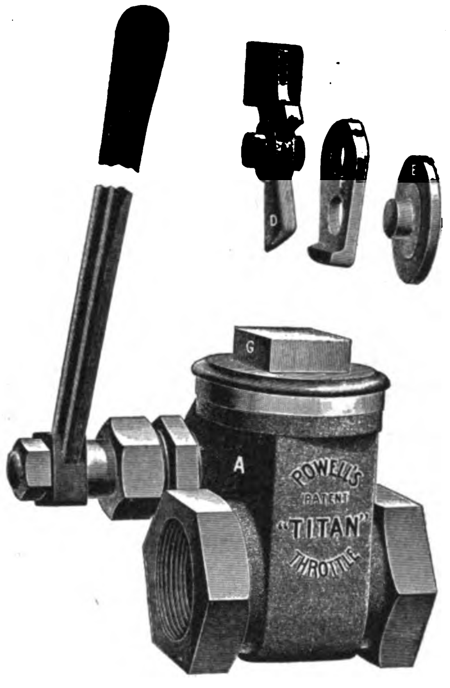


FIG. 4.—LEVER THROTTLE VALVE.

EIGHT-POLE MOTORS AND GENERATORS.

Motors of the type shown by Fig. 2 were primarily designed by the B. F. Sturtevant Company, of Boston, for the direct driving of large fans at low rotative speeds, which fit them also for direct connection to machine tools. The magnet frames are of cast steel, cast iron or wrought iron, according to size or requirements. In the smallest size the field cores are cast with the frame and the pole shoes only are removable; but, in the larger sizes readily detachable cores of wrought iron are bolted to the frame. Barrel wound armatures of the toothed-hollow-drum type are usually employed. The laminations are of special steel plate, mounted in each case upon a cast-iron spider, the hub of which is extended to support the commutator. All machines, except those for very low speed and high voltage, are bar wound, the two-circuit type being usually adopted. These machines are built in sizes from 1 to 50 horse-power, the ratings being based on a speed of 100 r.p.m.

The eight-pole generators are of the same design as the motors, and in the larger sizes the shunt and series coils of the field windings are wound and insulated entirely separately. The brush-holder rigging for supporting the holders is so arranged that brushes of opposite polarity are carried on independent rings which are attached to, but insulated from, a common ring which is readily detachable. The same system of protection against oil and water is employed as in the construction of the other types of machines of Sturtevant manufacture. The large radiating surface and ventilation, it is claimed, make it possible to run these machines at full speed with a maximum temperature rise not exceeding 54° on the hottest part. All sizes are provided with self-aligning, ring-oiling bearings, the sizes below the 15-h.p. motor being supported in tripod hangers, while the larger sizes are equipped with pedestals and complete bases. The generators, like the motors, are built in ten sizes, ranging in capacity from 3 to 100 kilowatts.

LEVER THROTTLE VALVE.

Figs. 3 and 4 illustrate a new lever or quick-opening throttle valve made by the William Powell Company, of Cincinnati, Ohio. Referring to the illustration, *A* is the body of the shell, *B* is a spindle, *C* is the carrier terminating in a tapering wedge, *D*; *F*, *F*, are two links loosely coupled to the carrier at its upper end, while the lower ends of the links engage the studs of the discs, *E*, *E*. In operation the discs are brought to their position opposite the seats, and then come to rest before any wedging device is brought to bear on them. The wedge end of the carrier, *C*, then passes between the studs of the stationary discs and forces them firmly against their seats. A reverse movement of the lever first withdraws the wedge before the discs are unseated. The discs then collapse, and a further movement of the lever brings them to the position of full opening. All of the parts are made to gauge, and are, therefore, interchangeable. The points of excellence claimed by the manufacturer are that they

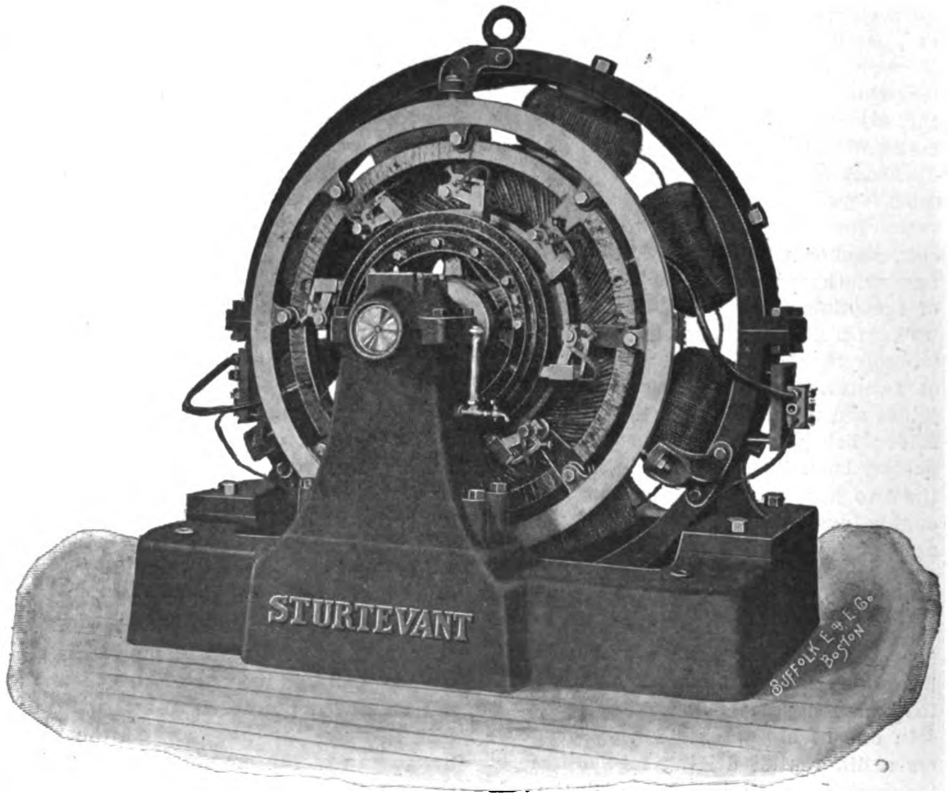


FIG. 2.—STURTEVANT EIGHT-POLE ELECTRIC GENERATOR.

positively close without leak when the lever is moved full stroke, and that, owing to the peculiar construction described, they open with ease under pressure. This construction also dispenses with the use of the by-pass in the larger valves.

CHAIN PULL SOCKET.

The chain-pull socket illustrated by Fig. 5 and made by H. Hubbell, of Bridgeport, Conn., was designed to take the place of the key socket on fixtures not within easy reach. The chain may be of any length to meet different requirements; one pull turns on the light and the next extinguishes it. All of the parts are carefully made and adjusted, the action is said to be smooth, and the glass globe covers the socket, which often mars the symmetry of the fixture. The sockets are fitted with Edison, T. H., or Westinghouse bases, and by their use every light is under immediate control irrespective of small switches, while the discomfort attendant upon reaching for the key socket is avoided.

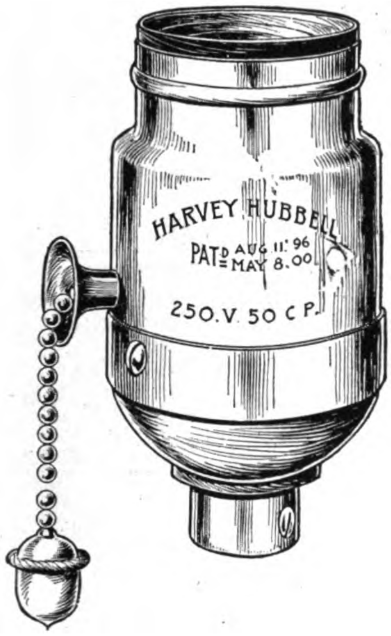


FIG. 5.—CHAIN PULL SOCKET.

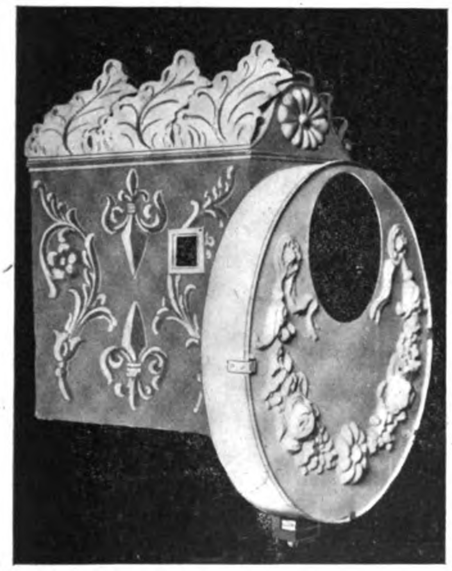


FIG. 6.—LAMP FOR STAGE ILLUMINATION.

ARC LAMP AND COLOR SCREENS FOR STAGE ILLUMINATION.

The illustration herewith shows a form of apparatus manufactured by Baker & Fox, of Brooklyn, N. Y., which is designed to supersede the methods now in vogue for controlling the color effects used in stage illumination. The machine is essentially a lens-box, containing an automatic focusing arc lamp, and having attached to it a color wheel with the necessary mechanism for rotating it, and also for locking it when the desired screen has arrived at the proper place in front of the lens. This mechanism, together with the arc lamp, is under the control of the operator at the switchboard on the stage, and may be placed out of the line of vision of the audience, below the level of the balcony rail. Fig. 6 shows the machine ready for installation, the various colored lights appearing in rotation through the circular opening in the front at the will of the operator. Fig. 7 shows the machine with the cover of the wheel-box taken off and the screens removed from the wheel, so as to reveal the mechanism; while Fig. 8 shows the automatic focusing arc lamp used in connection with the apparatus. As shown by Fig. 7, four colors may be displayed; but more might be used by enlarging the wheel. Any number of these machines, it is said, may be placed around the balcony of a theater and operated by the switchboard attendant either singly or simultaneously. Where it is desired to use the apparatus for display advertising, etc., an automatic switch may be employed to control the mechanism.

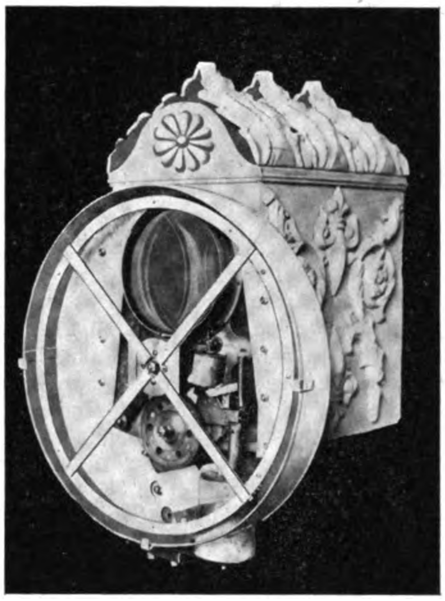


FIG. 7.—LAMP WITH WHEEL-COVER REMOVED.

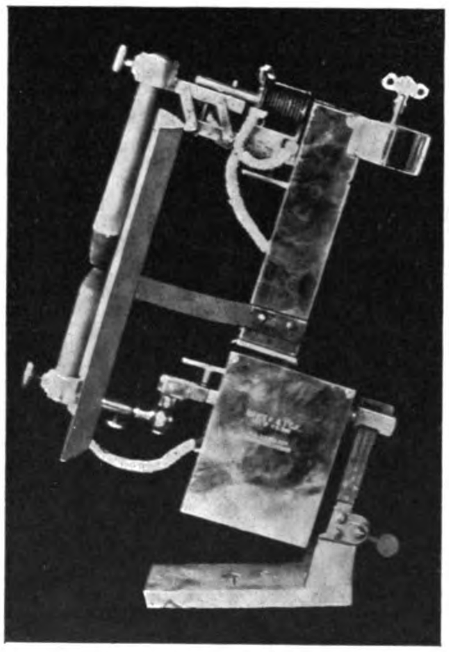


FIG. 8.—AUTOMATIC FOCUSING ARC LAMP.

STEAM EXHAUST HEAD.

Fig. 9 herewith shows the Sims exhaust head, which is manufactured by the Sims Company of Erie, Pa. In operation the exhaust steam is constrained to pass out of four openings, marked *A* in the illustration. These openings are tangential to the exhaust and are designed to impart a whirling motion to the steam, which strikes the ribs *B* with sufficient force to expel the water held in suspension. An unusually large area of cooling surface is said to be exposed and what little exhaust steam may be left passes around the truncated cone shown at *C* and the inverted cone *D*, both of which are intended to act as condensers. The balance of the exhaust steam passes out as vapor, without noise. The heads are made of heavy galvanized iron with lap-riveted joints which are also soldered. The bottom is a heavy casting threaded to screw on the end of the exhaust pipe.

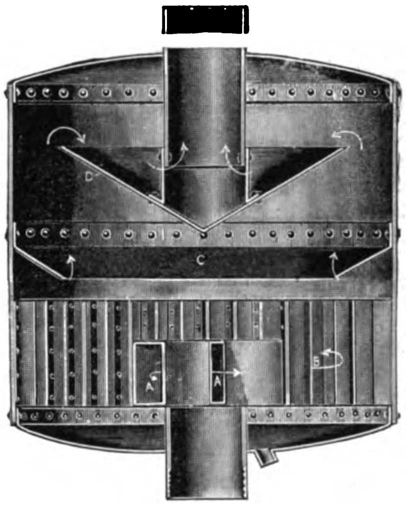


FIG. 9.—"SIMS" EXHAUST HEAD.

FIRE ALARM AND POLICE SIGNALPHONE.

Fig. 10 herewith shows a newly patented alarm box with telephone communication, made by the Yurgas Signalphone Manufacturing Company of Milwaukee for fire, police and night watch service. The apparatus is enclosed in a strong water-proof iron box; the wires leading to it being encased in an iron pipe directly above it, up to a point high enough to be out of reach. The telephone is provided with a solid-back transmitter, pony bipolar receiver and a strong induction coil; and to insure immunity from corrosion of all points of contact, platinum contacts are used with aluminum springs, while the other parts affected by rust are given a rust-proof finish. The central battery system is used, with Fuller batteries to supply the current. The company also makes a small telephone for hotel and factory service, as shown by Fig. 11. It is also operated on the central energy system, and is provided with a solid-back transmitter, double-pole receiver with rubber shell and lock-nut binding-posts, a "King" vibrator and a 250-ohm induction coil. The removal of the receiver from the hook actuates a drop on the central switchboard, as in the case of the latest types of central energy systems.

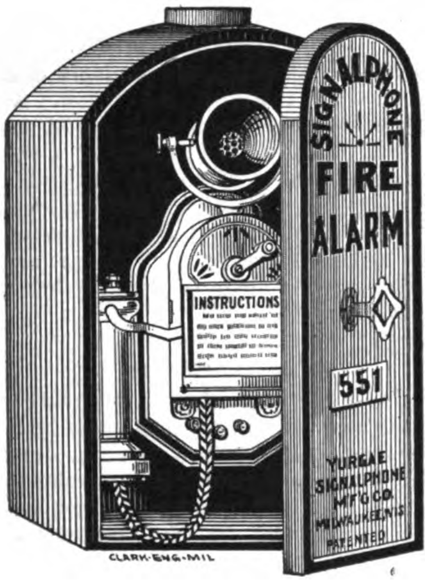


FIG. 10.—SIGNALPHONE.

A THREE-AMPERE SNAP SWITCH.

The Marshall-Sanders Company, Boston, Mass., is manufacturing a compact and highly efficient form of snap switch which is illustrated by Fig. 12 herewith. This type was brought out to meet the demand for a reliable switch smaller than the 5-ampere size, which has heretofore been the smallest snap switch. A large proportion of 5-ampere switches, as is well known, have been used to control one, two or three lamps; whereas the capacity of the switch is ample for 7 or 8 lamps. The new Marshall-Sanders switch has 3 amperes capacity, so that it may be used for any number of lamps up to 5 on a 110-volt circuit. The switch, although small, is substantially constructed, having nickel-plated piano-wire springs and a stout handle. The cover is lined with a cup of fiber made without seam or joint.

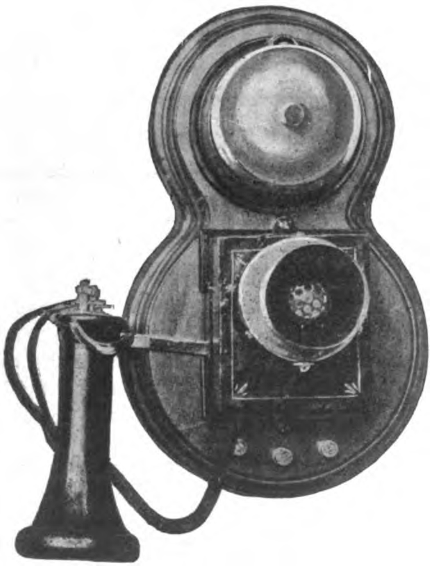


FIG. 11.—INTERIOR TELEPHONE SET.

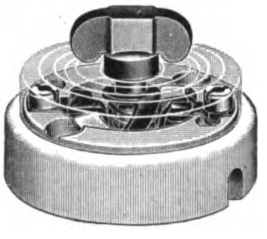


FIG. 12.

BAUM SEPARATORS.

A steam separator and purifier of interesting construction, manufactured by the Baum Separator Company, Reading, Pa., is illustrated herewith. Fig. 13 represents the standard horizontal form for general service and Fig. 14 shows sectional views taken on horizontal and vertical planes. Separation is effected by the impingement of the steam upon vertical ribs projecting from the surface of a semi-circular deflecting plate. The moisture or oil, as the case may be, adheres to the ribs and trickles down into the bulbous receiver below. Careful inspection of the upper part of the sectional engraving will show that the steam does not strike any surface flatly, but always at an angle; the result is that such particles of moisture or oil as may strike the ribs with sufficient force to prevent immediate adherence will not rebound back into the steam current, but will glance off at an angle and lodge either upon the curved surface of the deflector or, in an extreme case, upon the neighboring rib. The builder states that the shape of the deflector also has the advantage of directing the general course of the steam along curved paths in contradistinction to forcing it to make sharp turns; this fact, it is explained, allows the deflector to be placed very near the inlet, so that no steam is likely to get through without being relieved of its moisture (or oil).

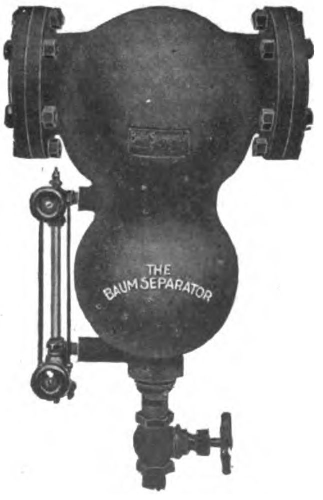


FIG. 13 —HORIZONTAL FORM, BAUM SEPARATOR.

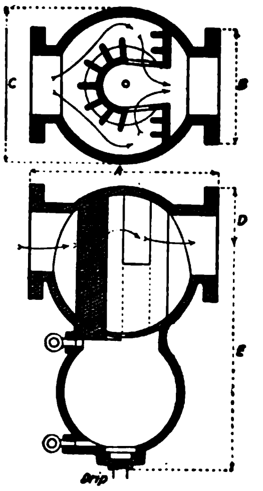


FIG. 14.—TRANSVERSE AND VERTICAL SECTIONS.

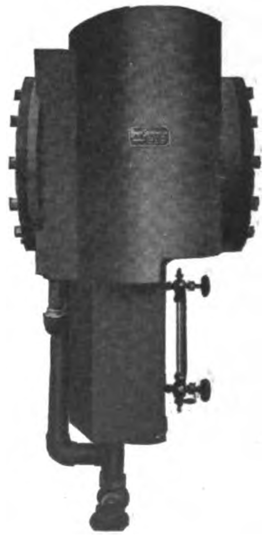


FIG. 15.—OIL SEPARATOR FOR CONDENSING ENGINES.

Fig. 15 illustrates a form of oil separator for use in conjunction with condensing engines. The general principle is the same, but the deflector plate is made considerably flatter (the velocity of exhaust steam at this point usually being comparatively low) and water circulation is provided at the back of the deflector plate, as indicated by Fig. 16. The ob-

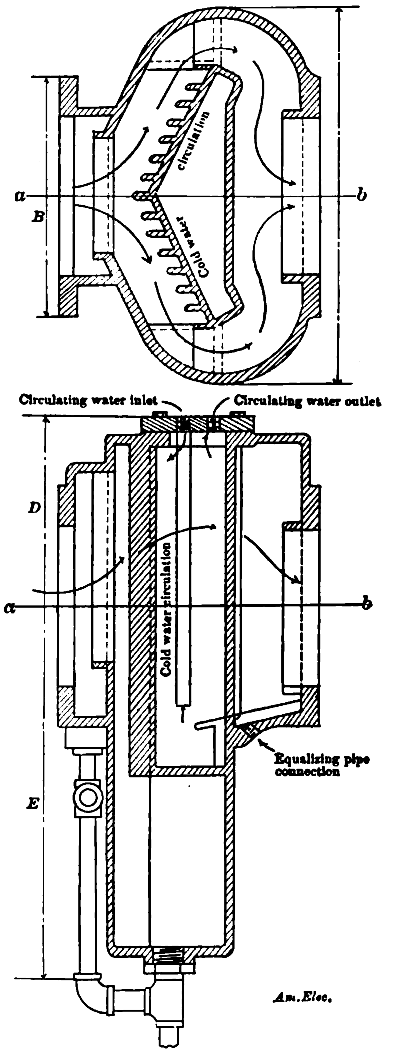


FIG. 16.—SECTIONS OF OIL SEPARATOR.

ject of this water circulation is to cause a film of moisture to be deposited on the steam side of the plate, which it is said isolates the oil from the impinging steam, and permits it to trickle into the oil receiver.

IMPROVED TRANSFORMER CONSTRUCTION.

The Kuhlman Electric Company, Elkhart, Ind., in the development of its present type of transformer has effected many notable improvements in the details of construction. For example, the casing of the transformer, instead of being made of cast-iron is made of stout sheet metal, which reduces the weight and consequently facilitates handling the transformer. The transformer is of the core type, operated in oil, and an inner diaphragm of vulcanized fiber is provided about the coils and core, leaving a space of about ½ in. on each side. This results in two vertical passages from top to bottom of the transformer, one between the fiber diaphragm and the core, and one between the diaphragm and the sheet-metal case. The result is that there is a continuous circulation of oil, the warm oil next to the core and coils rising to the top and being replaced by the cooler oil drawn from the chamber between the diaphragm and the case. In this connection the thin metal case has the additional advantage that increased radiation of heat is secured, due to the better heat-transmitting property of the material.

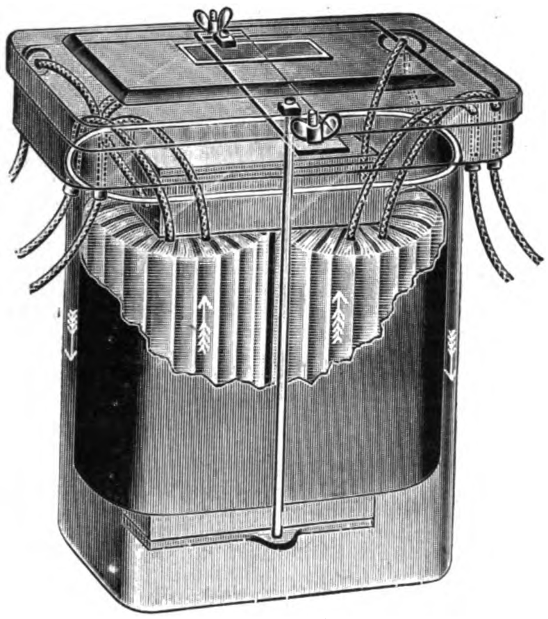


FIG. 17.—KUHLMAN TRANSFORMER.

Transformers for subway work are provided with a lid similar to a diving which makes it impossible for water to get into the case, even though the transformer were completely submerged; lead-covered cables are used for the terminals.

The company includes in its line a transformer for individual arc lamps supplied from constant-potential circuits, which eliminates the reactive coil usually employed in series with alternating-current lamps on such circuits, the transformer reducing the line voltage to the proper voltage for the lamp. The secondary winding is provided with several taps so that different voltages may be obtained to suit different lamps without having to carry in stock several kinds of transformer. These transformers are supplied either with oil-type cases or ventilated cases for operation without oil.

THE BERNARD COMPANY AT THE PAN-AMERICAN.

The E. G. Bernard Company, of Troy, N. Y., has an exhibit out of the usual path of the visiting electrical man, and, therefore, special attention should be called to it. As the electric fountain is located over half a mile from the service plant and is out of range of the 110-volt service, the E. G. Bernard Company offered to put in a motor-generator set and switchboard at the edge of North Basin (in which the electric fountain is located) and transform the 500-volt current from the power service into 110-volt current for the searchlights of the fountain. This offer was accepted and a small building erected for the apparatus on the west side of the basin. A 135-h.p. motor-generator furnishes the current for the searchlights and a 3-h.p. set supplies the lights in and around the building. There is also shown a 9-kw. 125-volt generator. Whitney instruments are used on the switchboards (there being a separate switchboard for each motor-generator) and Ward Leonard circuit-breakers and starting rheostat are in the circuit of the 130-h.p. motor. The company has fixed up its building with regard for the comfort of visitors who find their way down to the North Basin, and all electrical men are welcome.

PERSONALS.

MR. C. O. BAKER, JR., the well-known platinum refiner, recently made a visit to the Pacific coast.

MR. W. L. CANDEE, managing director of the Okonite Company, New York, has returned from an extended visit to Europe.

MR. LEON L. WILLIAMS, an electrical engineer well known throughout the South, has been appointed city electrician at Meridian, Miss.

MR. FRANK J. SPRAGUE has returned to New York after a considerable stay in Europe. Most of Mr. Sprague's time while abroad was spent in London, in connection, it is understood, with electric-railway business.

MR. J. E. TOWNSEND has resigned the managership of the Lima (Ohio) Electric Light & Power Company to accept the position of general manager of the lighting department of the Northern Ohio Traction Company, Akron, Ohio.

MR. C. B. SMITH, of Toronto, Ontario, has been appointed resident consulting engineer to the Canadian Niagara Power Company, the corporation formed for the purpose of putting in a power plant on the Canadian side of the Niagara River.

MR. J. F. COLEMAN, senior partner of the engineering firm of Coleman & Malochee, New Orleans, La., and also a member of the City Engineer's staff, has resigned his position in the municipal engineering department in order to devote his entire time to the rapidly-growing business of his firm.

MR. R. T. GUNN, for some time past superintendent of the Lexington (Ky.) Railway Company, has resigned that position to accept a similar one with the Norfolk (Va.) Railway Company. In his new position Mr. Gunn will have charge of the station and lighting departments of the Norfolk company.

PROF. GEO. D. SHEPARDSON, principal of the department of electrical engineering in the University of Minnesota, Minneapolis, Minn., and a well-known authority on electric train lighting, has been appointed a member of the Jury of Awards in the transportation section of the Pan-American Exposition.

MR. J. E. WILSON, who for nine years was connected with the Pettingill-Andrews Company, and more recently with the Stuart-Howland Company, has organized the Electric Supply & Maintenance Company at Troy, N. Y. Mr. Wilson is president of the new company, and has established headquarters at 476 Eighth Street, Troy.

MR. D. W. COOKE, who is recognized as being one of the most capable railroad passenger department men in the country, has been appointed general passenger agent of the Erie Railroad Company. Mr. Cooke, although not quite 38 years old, has had an extensive experience in railroad work, having held positions of almost every grade in the passenger departments of several of the most prominent American railroad systems. His promotion to the position of general passenger agent of the Erie system is a well-merited recognition of the ability previously displayed in the Erie passenger department.

MR. G. V. FLYNN, who has been connected with the New York sales office of the Westinghouse Electric & Manufacturing Company, has resigned his position there to embark in electrical contracting. Mr. Flynn has had an experience covering twelve years in the electrical field, and is thoroughly well equipped. He has associated with him Mr. H. J. Reilly, Jr., who is well and favorably known in the business circles of New York. They have opened offices and warerooms at 72 and 74 Trinity Place, New York, under the firm name of G. V. Flynn & Co., and are prepared to handle all kinds of electrical contracts, making a specialty of isolated plant work.

TRADE PUBLICATIONS.

ELECTRICAL SUPPLIES. Marshall-Sanders Company, Boston, Mass.—A pocket-size catalogue, containing illustrations and prices of incandescent lighting supplies.

LINE CONSTRUCTION MATERIAL. Eureka Electric Company, Chicago.—A pamphlet catalogue of construction tools and line material, which contains illustrations and prices of all standard tools, appliances and supplies.

HIGH-POTENTIAL SWITCHES AND FUSES. Stanley Electric Manufacturing Company, Pittsfield, Mass.—This is bulletin No. 118, describing S. K. C. switches, fuses, and combined switches and fuses for potentials of from 5000 to 60,000 volts.

MECHANICAL DRAFT USERS. B. F. Sturtevant Company, Boston, Mass.—A handsomely-executed pamphlet, containing a list of those who are using the Sturtevant system of mechanical draft, which is built to give both forced and induced draft.

PRIMARY CIRCUIT FUSE BOXES. Fort Wayne Electric Works, Fort Wayne, Ind.—An eight-page folder, containing illustrations and prices of the Wood high-tension fuse boxes for primary alternating-current circuits.

ELECTRICALLY-DRIVEN PUMPS. General Electric Company.—This is bulletin No. 4261, describing small pumps, belt-driven by motors mounted on the same base, and designed primarily for filling reservoir tanks in hotels, office buildings, large residences, etc.

ENCLOSED ARC LAMPS. General Electric Company.—This is bulletin No. 4246, in which is discussed enclosed arc lamps for 220 and 550-volt power circuits. The bulletin is unusually ornate, containing illustrations of various installations finely executed in half tone.

DIRECT-CONNECTED GENERATORS. Western Electric Company.—Bulletin No. 2003, describing an interesting line of direct-connected machines for lighting and power. These machines are built in sizes ranging from 30 to 550 kilowatts, and are wound for either 125 or 250 volts.

COMPENSATED REVOLVING-FIELD ALTERNATORS. General Electric Company.—This is bulletin No. 4258, which supersedes bulletin No. 4206, and contains a detailed description, fully illustrated, of General Electric compensated alternators, both belt-driven and direct-connected.

CONVEYING MACHINERY. The Jeffrey Manufacturing Company, Columbus, Ohio.—Circular No. 63, of small pocket size, containing what might be termed a synopsis of the Jeffrey Company's line, in the form of illustrations showing the different types of conveying apparatus and some notable installations.

SEWING-MACHINE MOTORS. General Electric Company.—This is bulletin No. 4247, describing a very compact type of sewing-machine motor which is built for both alternating and direct-current circuits. The speed is regulated by a treadle which presses an idler pulley against the belt and thus varies the slip.

GENERAL TELEPHONE CATALOGUE. The Stromberg-Carlson Telephone Manufacturing Company, Chicago.—This is a very handsome production, of standard catalogue size, containing illustrations and brief descriptions of the company's entire line, which includes instruments, switchboards and accessories for all modern classes of telephone service.

ELECTRICAL FIXTURES AND SUPPLIES. The Western Electrical Supply Company, St. Louis, Mo.—This is catalogue No. 28, in which is illustrated and described a comprehensive line of electrical fixtures, ranging from a simple goose-neck bracket to the most ornate electrolier. The fixtures are illustrated by half-tone engravings and the catalogue is well executed.

ARE YOU THE ENGINEER? The International Correspondence Schools, Scranton, Pa.—This is an eight-page pamphlet of pocket size containing the series of questions asked at a recent examination of applicants for stationary engineers' licenses. The pamphlet also contains arguments for the correspondence system of education and its advantages to engineers and firemen.

WHITE "HANDY ANDY" GASOLINE ENGINE. The Globe Iron Works Company, Minneapolis, Minn.—A folder, giving particulars of a 1½-h.p. White gasoline engine which goes under the name of "Handy Andy" because of its all-around convenience. The ignition is electric, the sparking current being supplied from a small generator mounted directly on the engine base and driven from the pulley.

FLANGED PIPE FITTINGS AND GATE VALVES. Crane Company, Chicago.—This is the 1901 edition of the Crane Company's valuable pamphlet containing complete dimensions of flanged steam-pipe fittings and gate valves in all sizes. The measurement on these fittings has been changed in some cases, so that it is extremely important for those interested in steam-pipe fittings to have a copy of this pamphlet.

PORCELAIN EDISON-TYPE FUSE BLOCKS. Peru Electric Manufacturing Company, Peru, Ind.—A vest-pocket catalogue, containing illustrations of Edison-type main and branch fuse-blocks of all standard forms for link fuses. The subject matter is very conveniently arranged, each illustration having its catalogue number and fuse capacity, together with the function of the block, printed below the engraving.

TWENTIETH CENTURY ENGINE. The Lane & Bodley Company, Cincinnati, Ohio.—This is the fiftieth anniversary edition of this company's catalogue, and is devoted to the Twentieth Century heavy-duty engine of the company, fully illustrated in a recent issue of this paper. The catalogue is fully illustrated, and contains complete data relating to the dimensions and performance of the line of engines described.

PARAGON ENCLOSED MULTIPOLAR DYNAMOS AND MOTORS. Paragon Fan & Motor Company, New York.—This is bulletin No. 64, illustrating and describing the multipolar form of machine built by this company. This form is built in sizes ranging from 1 to 10 horse-power, or ¾ to 7½ kilowatts. The field magnet consists of a cast-iron yoke ring of the semi-enclosed type and pole-pieces built up of stamped laminations. The machine is entirely enclosed by end plates carrying the journal boxes.

A CONVENIENT FOLDER.—The Westinghouse Companies are distributing a printed invitation to visit the various Westinghouse exhibits at the Pan-American Exposition, a most convenient feature of which is a map of the Exposition grounds with all of the buildings, courts, etc., indicated in large type, so that a stranger can easily find his way to any part of the Exposition grounds. The folder contains also a list of Westinghouse exhibits, which are numerous and interesting.

ELECTRICAL AND GAS FIXTURES. Commercial Electrical Supply Company, St. Louis, Mo.—This is a particularly well-executed catalogue of electrical fixtures. The illustrations show the fixtures in relief on a solid black background, bringing out the details rather more clearly than illustrations in black on white would. The line of fixtures is very comprehensive, including everything from a simple straight wall bracket to most ornamental chandeliers, as well as hall lamps of various designs, portables, and a full line of glassware.

AIR COMPRESSORS. New York & Franklin Air Compressor Companies, New York.—This is Catalogue B, of standard size, containing illustrations and descriptions of the line of air compressors built by these two companies. The compressors are made both single and duplex, of course, and in both horizontal and vertical forms. The catalogue is prefaced by some wholesome advice concerning the selection of an air compressor and also contains useful engineering information on the comparative economy of air compressors and the installation of compressed air equipments.

CORLISS ENGINES. The Vilter Manufacturing Company, Milwaukee, Wis.—A pamphlet catalogue, in which is illustrated and described the well-known Vilter-Corliss engine, which is built in all of the usual forms—simple, tandem compound, cross compound, etc. The catalogue also contains a description of the Vilter Company's counter-current condenser and illustrations of other apparatus, such as refrigerating machines, feed-water heaters, pumps, etc. In the back of the book are several tables, which will be found extremely convenient by operating engineers.

NIAGARA FALLS POWER. The Cataract Power & Conduit Company, Buffalo, N. Y.—A beautifully-executed brochure, containing a summary of the applications of the power derived from Niagara Falls and converted by the Niagara Falls Power Company. The illustrations in the book show partial views in the Niagara Falls power house, the transformer house at Niagara Falls, the converting apparatus of the Pittsburg Reduction Company, the Castner Electrolytic Alkali Company, the terminal transformer station in Buffalo, the central station of the Buffalo General Electric Company, and many other establishments which take power from the Niagara Falls Company's lines.

BUSINESS NEWS.

GEORGE J. STOCKER, of St. Louis, the well-known manufacturer of cooling towers, has removed from 2831 Victor Street to 2833 South Kings Highway Boulevard.

A COMMUTATOR NECESSITY.

For Sale by all Supply Houses.

Upon receipt of this coupon we will send FREE, sample stick.

Name............ ....

Address....... ....

A. E.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.

50c. per Stick. $5.00 per Dozen.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO.

CROSS OIL FILTERS.—The Burt Manufacturing Company, Akron, Ohio, states that more than 100 Cross oil filters are used in the plants of the United States Steel Corporation.

THE C. & G. COOPER COMPANY, Mt. Vernon, Ohio, builder of the well-known Cooper-Corliss engines, has established a New England office in the Weld Building, Boston, in charge of Mr. B. A. Church.

THE SMITH & HEMENWAY COMPANY, New York, representatives of the Utica Drop Forge & Tool Company, have an interesting exhibit at the Pan-American Exposition in the Electricity Building, forming a part of W. Jac Marland's collective exhibit.

THE GLASS WOOL MANUFACTURING COMPANY, Chicago, is a new concern which recently started up for the purpose of manufacturing glass wool for storage-battery insulation. The sample of this company's product which has been received appears to be all that can be desired.

THE WALLACE-BARNES COMPANY, Bristol, Conn., manufacturer of small springs of all kinds, has just completed an addition of 36 x 110 ft. to its factory. The new part of the factory is fully equipped with the latest type of machinery, and will enable the company to keep abreast of its increasing orders and make prompt shipments.

THE MOLONEY ELECTRIC COMPANY, of St. Louis, manufacturer of the well-known Moloney transformers, has found its Eastern business increasing so rapidly as to necessitate establishing an agency in Philadelphia in addition to the recent appointment of H. B. Coho as New York agent. Walker & Keppler are the Philadelphia representatives.

THE S. MORGAN SMITH COMPANY, of York, Pa., recently shipped to the Rhodhiss Manufacturing Company, Rhodhiss, N. C., two pairs of 36-in. and one 30-in. McCormick turbines mounted in iron cases, with the necessary supply pipes, draft tubes, couplings, bearings, etc. This equipment is for use in a large water-power plant on the Catawba River.

THE STANDARD PAINT COMPANY, New York, has issued a card of invitation to the fraternity at large, extending the use of its pavilion at the Pan-American Exposition as headquarters where appointments may be kept and mail sent. The pavilion, which is an extremely handsome one, is located near the east Amherst Gate, directly south of the Canadian Building.

THE STEWART HEATER COMPANY, Buffalo, N. Y., states that the fire which damaged its works on July 25th, while of course subjecting the company to great inconvenience, will not affect its deliveries in the least. Arrangements were immediately made to continue business without interruption, and all orders for the well-known Otis feed-water heaters will be filled promptly.

THE BOSTON & MONTANA TURBINES.—In the description of the 54-in. McCormick turbines installed in the plant of the Boston & Montana Consolidated Copper and Silver Mining Company, which was published on page 415 of the last issue of this paper, it was erroneously stated that these turbines were capable of developing 2000 horse-power. The capacity of the wheels is 2800 horse-power under a 40-ft. head.

W. H. CHAPMAN, manufacturer of the new type Chapman voltage regulator, has transferred his business to The Portland Company, of Portland, Maine, which company will continue the manufacture of the regulator under the immediate supervision of Mr. Chapman, who becomes chief engineer for the company. This company is the one of the oldest in the city of Portland, having been established since 1846.

PHENIX CHEMICAL WORKS, Brooklyn, N. Y., reports a very wide sale for "Signaloid," a coloring and frosting liquid for incandescent lamp bulbs; the company is in receipt of orders from almost all parts of the civilized world. It is claimed that this preparation will not peel, chip or crack, and will outlast the life of the lamp filament. It is also claimed that none of the ingredients in the preparation is a narcotic nor of a character in the least injurious to persons using it.

THE STILWELL-BIERCE & SMITH-VAILE COMPANY, Dayton, Ohio, recently closed a contract with the Wisconsin Traction, Light, Heat & Power Company, Appleton, Wis., for an extensive outfit of Victor turbine water wheels. The plant will consist of two units, each comprising three pairs of 42-in. horizontal turbines capable of developing 3200 horse-power, and designed to drive alternators; together with two 24-in. horizontal wheels of 150 horse-power for driving the exciters.

CLING-SURFACE FOR THE SATURDAY NIGHT LOAD.—The Cling-Surface Manufacturing Company, Buffalo, N. Y., has received among numerous other testimonials a letter from the Albuquerque (New Mexico) Electric Light Company, in which the company says: "We cannot speak too highly of Cling-Surface. Have put all sticky belt dressings on the shelf and Cling-Surface has the foremost place in our plant. We would not be without it, especially for the Saturday night load."

THE CENTRAL ELECTRIC COMPANY, Chicago, announces that it is carrying a full stock of Manhattan arc lamps and Pittsburg transformers in its Chicago storehouse, and can fill any orders promptly from stock. The Manhattan arc lamp is too well known by the trade to require extended mention. The Pittsburg "Type K" transformer, while comparatively new, has, within the past year, attracted a great deal of attention among central station managers by reason of its excellent performance, and is now in wide use throughout the country.

The Telephone Service is The Quickest Messenger.

Rates in Manhattan from $5 A MONTH. One Year Contracts. Monthly Payments.

NEW YORK TELEPHONE CO.
15 Dey Street. 111 West 38th Street.

CREAM FLUX

An Absolutely Non-Corrosive Insulating Soldering Flux FOR ALL METALS.

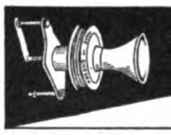
So EASILY APPLIED that all CAN USE IT.
So CHEAP that all SHOULD USE IT.
So EFFICIENT that all MUST USE IT.

PUT UP IN CANS AT
15c., 25c., 45c. and 75c.
SPECIAL PRICES IN QUANTITY.
SEND FOR TRIAL BOX.

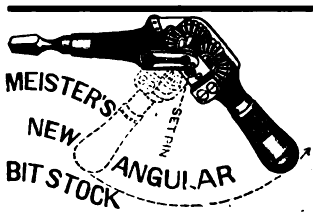
Endorsed by the National Board of Fire Underwriters and all users.
We guarantee it, and if not satisfactory, money will be refunded.
FOR SALE BY ALL SUPPLY HOUSES OR

CREAM FLUX CO., SOLE MANUFACTURERS, 100 Washington St., CHICAGO

BIG STICK, 35 CENTS.
Sample Free.
SOUTHWORTH & HARE,
Indianapolis, Ind.



GENUINE ERICSSON SWEDISH COAL-GRAIN.
MICROPHONE
THE PERFECT TRANSMITTER.
No Packing. No Adjusting. No Trouble.—Also Complete Line Long Distance Telephones.
Ericsson Telephone Company, 296 Broadway, N.Y.



OUR NO. 480.

For all first class Electrician's Tools, see the *Green Book* of Hardware Specialties.

SMITH & HEMENWAY CO.,
UTICA DROP FORGE & TOOL CO.,
296 Broadway, New York City.

An INCANDESCENT LAMP represents a large investment of cap'tal, ingenuity and skilled workmanship, it is sold at a price so low as to necessitate eternal vigilance in cutting costs to a minimum. A successful lamp manufacturer can not afford to experiment with poor materials. This explains the popularity of

BAKER & CO.'S PLATINUM
408 N. J. R. R. Ave., NEWARK, N. J. 120 LIBERTY ST., NEW YORK
We buy and Refine Platinum Scrap also

THE NEW PROCESS RAWHIDE COMPANY, Syracuse, N. Y., reports among recent contracts for New Process pinions one for the United States Mint at Philadelphia for six "noiseless" pinions 16 ins. in diameter and 6 ins. face, to be used in transmitting power from 50-h.p. electric motors to 9 in. x 10 in. rolling mills. These pinions go on intermediate shafts between the motors and the rolling mills. Six armature pinions for these same motors were shipped by the company some time ago. These are 12 2/3 ins. in diameter by 4 ins. face and run at 525 r.p.m.

THE STANDARD TELEPHONE & ELECTRIC COMPANY, Madison, Wis., announces that a note in one of our contemporaries to the effect that its plant was practically destroyed by fire was incorrect, and that the fire only damaged the plant to a slight extent. The company did not lose any of its machinery, and its factory operation was interrupted less than two days—merely the length of time necessary to adjust the loss with the insurance companies. The company's business has not been interrupted at all and the fire will not interfere in the slightest degree with the filling of orders.

THE RELIANCE ELECTRIC COMPANY, Milwaukee, Wis., was recently incorporated with a capital stock of $30,000, all paid in, for the purpose of manufacturing dynamos and motors from 5 horse-power up, principally for lighting and power purposes. The company advises us that its factory is equipped with the most modern machinery and states that its product will be of the highest possible standard. The officers of the company are as follows: Thomas Croil, president; W. J. McElroy, vice-president; F. J. Kipp, treasurer; H. B. Dewey, secretary and manager. Mr. F. T. Chapman, formerly of the Milwaukee Electric Company, is the electrical engineer of the Reliance Company.

500-KW. GENERATORS TO BE DRIVEN BY GAS ENGINES.—The Sprague Electric Company recently closed an order for three Lundell split-pole engine-type generators of special design, to be used in an unusually interesting plant. These machines are wound for 250 volts and are to be direct-driven at 100 r.p.m. by gas engines in the new works of the Lackawanna Iron & Steel Company; the gas engines will utilize waste gas from the coke ovens of the Lackawanna Company as fuel. These will probably be the largest generators so far direct-driven by gas engines in this country, and the utilization of waste gases for power purposes to such an extent, it is said, has never before been attempted in the United States.

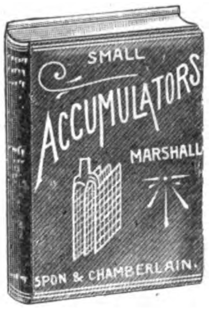
THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, the general sales agent for the Browning Manufacturing Company, reports that the success of the new type of small Browning generators and motors has been extremely gratifying. They state that these motors and generators have given entire satisfaction wherever they have been installed. They further state that these small machines are tested by a four-hour run at 10 per cent overload and a one-hour run at 50 per cent overload before leaving the factory. They are made of the best cast dynamo steel, slotted armatures, have self-oiling ring bearings and carbon brushes. These machines are made in sizes from 1/5 to 3½ horse-power, and from ⅛ to 2½ kilowatts.

THE WARREN COMPANY, INC., Chicago, is constantly receiving strong testimonials to the merits of its well-known pulley cover. The superintendent of the Ashtabula (Ohio) Electric Light Plant writes concerning the pulley cover as follows: "Replying to your favor of recent date concerning the pulley cover bought three months ago, we have to advise you that we are better pleased than we can express in words. We dressed a 40-in. pulley, having a 54-in. face and carrying the main belt from a 500-h.p. engine. This pulley had been giving trouble for a long time. It is a steel-faced pulley and the slipping on heavy loads caused a fluctuation of 6 volts, but since the pulley has been dressed we have absolutely steady voltage, and the belt runs so low that we cannot walk under it; whereas before treatment the upper stretch of the belt could not be reached with the hand while it was running. We get 14 ins. more lap on the pulley than before."

RUBEROID ROOFS AT KARLSRUHE.—The buildings in which the great art exhibition is to be held at Karlsruhe, Germany, next year, will be of themselves an attractive feature of the exhibition, in which American products will figure prominently. The buildings will be covered by the well-known Ruberoid roofing manufactured by the Standard Paint Company. At the present rate there will soon be no places in the civilized world where Ruberoid is not known. Large shipments of it were recently sent to the Russian Southwest Railway to cover the railway buildings, and the material has even gone to the Arctic regions. The Baldwin-Ziegler polar expedition took several thousand square feet of Ruberoid along because of its light weight and the economy of space that it affords. This material will be used to house the ship when it is abandoned in the far North for the journey over the ice on sleds, and also for building huts or shelters along the route.

FINE LIGHTING EFFECTS IN A CATHEDRAL.—I. P. Frink, of New York, manufacturer of the well-known Frink reflectors, recently designed for the Roman Catholic Cathedral at Baltimore, Md., what is said to be the most beautiful electrical display ever shown in a church in that city. The display consists of a lighting system for the statue of Our Lady of Lourdes, which is situated in the cathedral. The statue is of Italian marble, and on its head is a brass crown studded with tiny incandescent bulbs. According to the legend of Our Lady of Lourdes, roses grew out of the rocks where the apparition had stood, in order to convince a skeptical bishop. These roses are shown about the feet of the statue, being made of Australian porcelain with leaves of metal; inside each rose is an incandescent lamp, the effect being a soft illumination about the whole statue which contrasts beautifully with the more brilliant illumination from the circle about the head of the figure.

DRAKE, BREED & CO. is the style of an electrical engineering firm of high promise, established recently in Philadelphia. Messrs. Drake and Breed are both men of long experience in the electric-railway field. Mr. Drake was for years the right-hand man of the late Albert L. Johnson, and at the time of the latter's death was at the head of the great electric-railway system centering in Allentown, with the roads projected and building to connect New York and Philadelphia. He had been for a number of years vice-president and general manager of the Nassau System in Brooklyn, and held an important position with the street-railway system of St. Louis. Mr. Geo. Breed is a graduate of the U. S. Naval Academy, and was from 1890 until the time of the war with Spain connected with the General Electric and Westinghouse companies. He was retained by Mr. Johnson to design the power stations and supervise the electric equipments of his projected roads. The new firm was formed with a view to completing this work and to enable them to push efficiently other large enterprises now in hand.



Price, 50 Cts.

SMALL
ACCUMULATORS.

How to make the parts.
How to fit them up.
How to charge them.
How to run them.

BY P. MARSHALL.

Fully illustrated.
Cloth, 50 Cents.

Copies mailed, postpaid, on receipt of price.

SPON & CHAMBERLAIN,
12 Cortlandt Street, - NEW YORK.

PRATT INSTITUTE
BROOKLYN, N. Y.
TWO YEAR COURSES IN
Applied Electricity
AND IN
Steam and Machine Design
Write for Catalogue and Particulars.

SOLID TRAINS TO NORTHERN MICHIGAN.

The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

THE MASON
Reducing Valves
ARE THE WORLD'S STANDARD VALVES

For automatically reducing and absolutely maintaining an even steam or air pressure.

They are adapted for every need and guaranteed to work perfectly in every instance.

Write for full information and splendid references.

THE MASON REGULATOR CO. Boston, Mass., U. S. A.

American Electrician.

Vol. XIII. New York, October, 1901. No. 10

BRINGING UP TO DATE AN OLD-STYLE CENTRAL STATION.

THE REMODELED PLANT OF THE GEORGIA ELECTRIC LIGHT COMPANY.

The Georgia Electric Light Company was organized in 1890, buying out a small company which then lighted the city of Atlanta, Ga. The old plant was dismantled and a new station built on the site where the present central station is located. The then new station was typical of the practice of its day, containing a large number of small generating units which was added to as the business of the plant grew. These additions resulted, as such growth inevitably does in the case of an old-style plant, in the multiplication of machinery types and the conglomeration of small generating sets to such an extent as to overcrowd the station building and render operation difficult and expensive, so that the company in the spring of 1900 decided to reconstruct the entire station as well as the system, modernizing the complete plant. The work of making the changes was accordingly placed in the hands of Messrs. Ford, Bacon & Davis, engineers, of New York, who proceeded to bring the plant up to the standard of the latest modern practice.

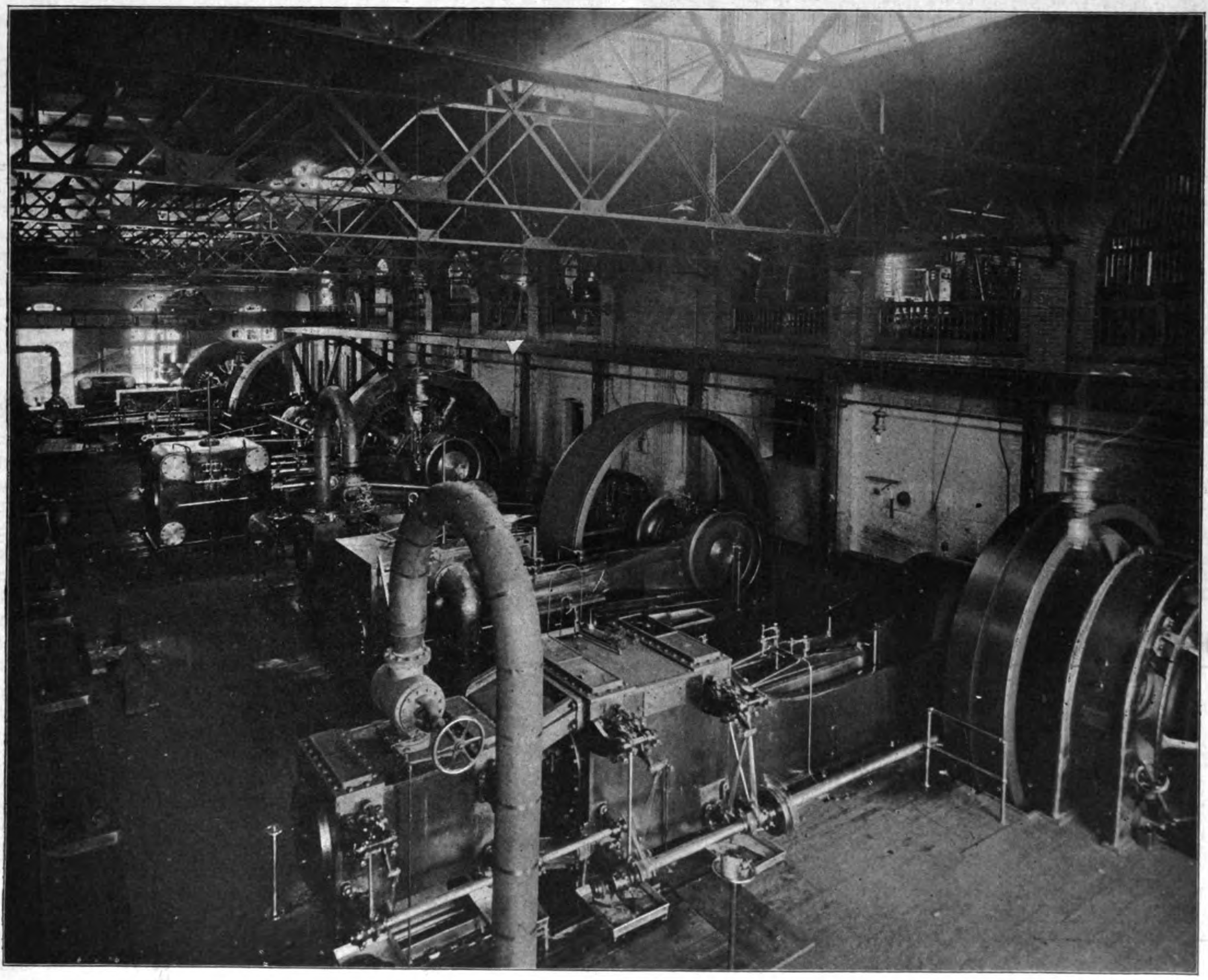


FIG. 1.—ENGINE AND GENERATOR ROOM OF THE GEORGIA ELECTRIC LIGHT COMPANY.

The general scheme of the present plant,

which is almost completed, is as follows: At the main station three-phase alternating currents are generated at 2500 volts and 60 cycles, and a primary distribution system for lighting and power purposes is supplied directly from the alternator bus-bars; this distribution system is restricted to that portion of the city outside of the fire district. The service within the fire district is all direct current, supplied by underground mains from a sub-station located at almost the precise center of the district. This sub-station receives three-phase alternating currents at the voltage and frequency above named, through underground feeders, and transforms these currents, by means of three-phase, two-phase transformers and rotary converters, into direct current, which is delivered to an ordinary three-wire 230-volt Edison distribution system. All arc lamps, motors, and incandescent lamps within the fire district are supplied from **these mains, while the lighting and power service without the district is all by alternating current. The municipal arc lamps outside the fire district are series arcs supplied through constant-current transformers in the main generating station. The main station also contains direct-current railway generators of the usu**al type, which supply the street-railway system of the city. These generators are reinforced by a rotary converter, and an additional rotary is to be put in which will also be used for the railway service.

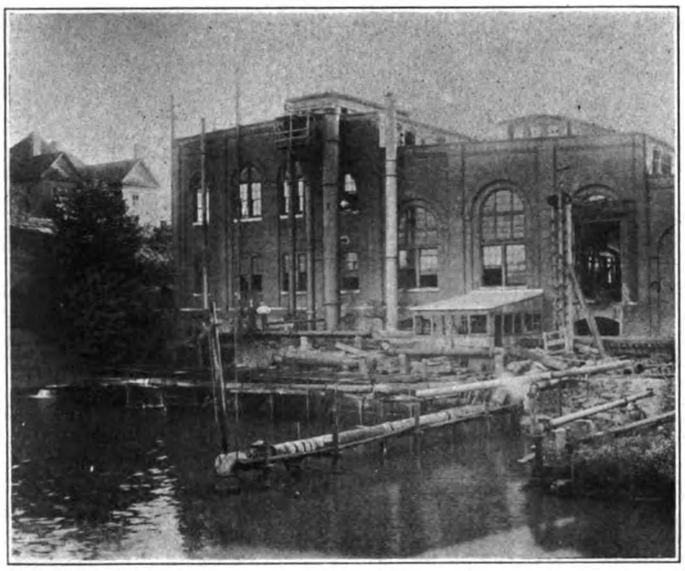


FIG. 2.—WATER CONNECTIONS AND CONDENSER.

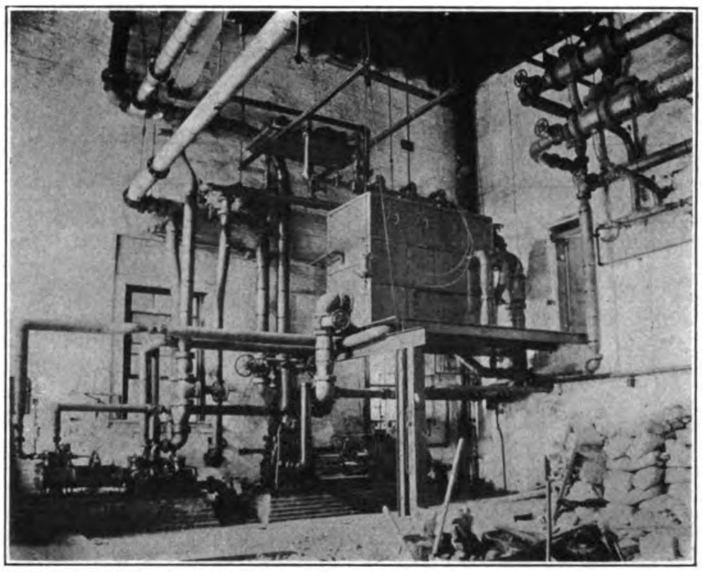


FIG. 4.—FEED-WATER PUMPS AND HEATER.

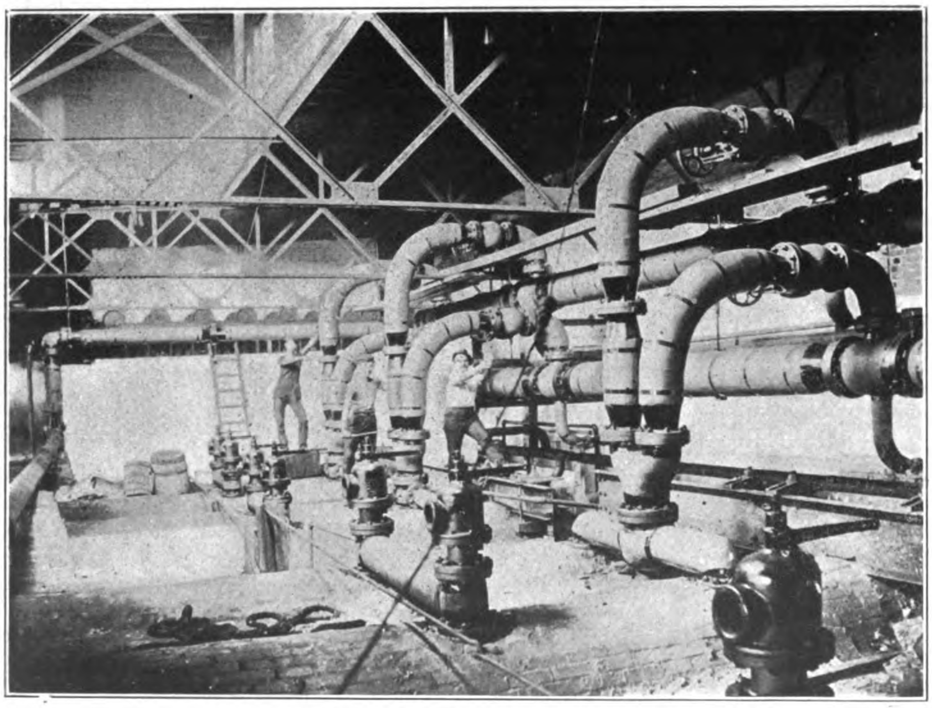


FIG. 3.—DUPLICATE BOILER DELIVERY PIPES AND HEADERS.

THE POWER HOUSE.

The power-house is a brick building 185 ft. long and 148 ft. wide, with a tar and gravel roof supported on steel trusses. The boiler and engine rooms run side by side the entire length of the building, the boiler room occupying 42 ft. of its width and the engine room 50 ft. The remaining 56 feet of width was formerly devoted to a line-shaft room on the ground floor **and a dynamo room immediately above it, the lower room containing two long line-shafts from which were belted a large number of small generating units located on the floor above. This lower room now contains railway generating units and has reserve space for additional equipment. The boiler room contains eight Babcock** & Wilcox boilers rated at 250 horse-power each, and two boilers of the same kind rated at 325 horse-power each. The boilers are set and connected in batteries of two. A wooden trestle runs throughout the length of the boiler room 18 ft. above the floor-level, on which railway tracks are laid. Coal cars are run in from the railroad on to this trestle track and the coal is dumped directly into coal bins in the boiler room. The boilers are hand-fired; chutes from the coal bins deliver the coal to the boiler-room floor immediately in front of the furnace doors. The ashes are removed by a trolley bucket operated by hand.

The steam-piping system comprises two headers in the boiler room, into which two mains from each pair of boilers (the boilers being permanently connected in batteries of two) deliver steam. These connections are shown clearly by Fig. 3. Individual mains in duplicate from these two headers lead over to the engines, so that any engine can be operated from either header or from both. All of the steam piping is extra heavy and was put in by the Benj. F. Shaw Company, Wilmington, Del. The fittings are also extra heavy and were supplied by the Crane Company and the Shaw Company; Chapman valves are used throughout. The feed-water piping is extra heavy and in duplicate, like the steam piping. All high-pressure-steam piping is covered with 1 in. of 85 per cent P. B. & Madison magnesia, 1 in. of hair felt wrapped with heavy sized paper, and a final layer of 8-ounce duck painted olive green. The fittings and flanges are painted black. A tapered collar of galvanized iron is provided on each flange, as shown in Fig. 3, in order to allow repairs to be made without interfering with the pipe covering.

The plant runs condensing and is equipped with a central Worthington condenser of 5000 horse-power capacity, and two Worthington triple-expansion duplex circulating pumps 6 ins. and 9 ins., and 16 ins. and 22 ins. x 15 ins., and one Worthington "dry vacuum" air pump 10 ins. and 18 ins. x 18 ins. Fig. 2 shows the condenser and water connections, which are located at one end of the building, near a pond from which both condensing and boiler-feed water are taken. There are two Green fuel economizers, the scrapers of which are driven by a 1½-h.p. induction motor. The usual outfit of steam boiler feed pumps is provided. The boiler supply is taken from the pond just mentioned, which is fed by springs and two artesian wells, the latter having a combined flow of 125 gals. a minute. The plant, of course, has connection with the city water mains for use in emergency. Before reaching the economizers the feed water passes through a Webster open heater (Warren Webster & Co., Camden, N. J.). Fig. 4 shows the arrangement of the heater and the boiler-feed pumps. The old brick stack has been retained; this is 7 ft. in diameter inside and 175 ft. high. Spencer damper regulators are employed to control the draft.

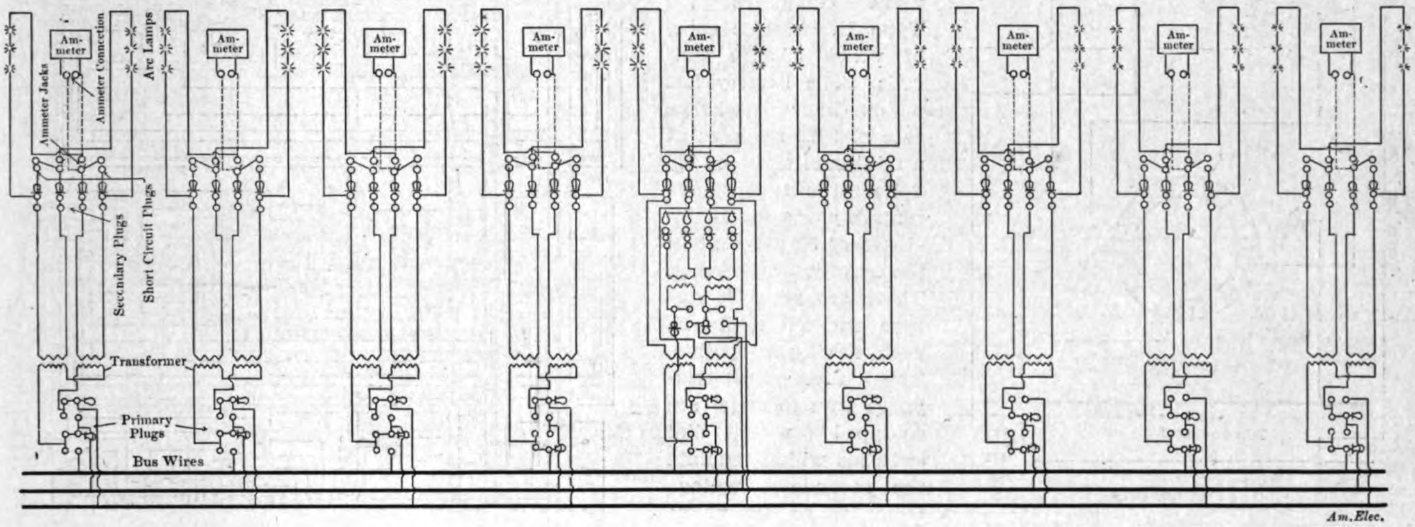


FIG. 5.—DIAGRAM OF CONNECTIONS, ARC-LIGHTING SWITCHBOARD.

The engine and generator equipment in the main engine room comprises one McIntosh & Seymour tandem-compound engine, 20 ins. and 44 ins. x 42 ins., direct-connected to a 700-kw. 600-volt General Electric railway generator, which it drives at 120 r.p.m.; two Rice & Sargent (Providence Engineering Works) cross-compound engines, 24 ins. and 50 ins. x 48 ins., each direct-connected to a 1000-kw. revolving-field General Electric alternator, which is driven at 100 r.p.m., and delivers three-phase currents at 2500 volts and 60 cycles; one Greene (Providence Engineering Works) cross-compound engine, 20 ins. and 40 ins. x 48 ins., running at 100 r.p.m., and driving, by means of a 48-in. belt, a 600 kw. revolving-field General Electric alternator which runs at 360 r.p.m. and delivers three-pnase current at 2500 volts and 60 cycles; one Harris-Corliss tandem-compound engine, 22 ins. and 40 ins. x 48 ins., which runs at 78 r.p.m., and drives a short jack shaft to which is belted several railway generators which have been retained from the old equipment.

The equipment in the room which was formerly occupied by the two line shafts consists of one Greene tandem-compound engine, 12¼ ins. and 28 ins. x 48 ins., belted to a 200-kw. General Electric railway generator and a 100-kw. Short railway generator; one Straight Line simple engine, 10 ins. x 14 ins., direct-connected to a 50-kw. 125-volt General Electric dynamo which runs at 275 r.p.m. and serves as an exciter for the alternators. On the floor above this room, which was formerly occupied by the small generating units, there are located another exciter driven by a 35-kw. induction motor; a 300-kw. two-phase Westinghouse rotary converter, which takes current through three-phase-two-phase transformers and delivers direct current at 600 volts to the street-railway system; and ten 100-light constant-current General Electric transformers of the "tub" type, supplying current at 7½ amperes to the municipal arc-lighting circuits.

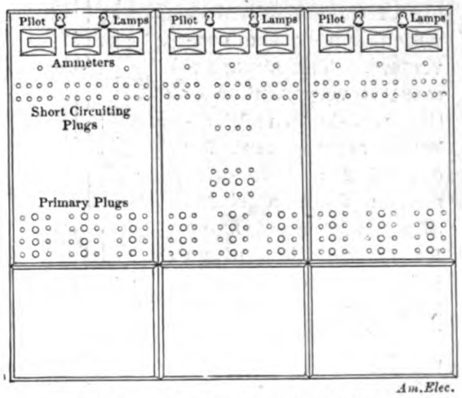


FIG. 6 —ARC-LIGHTING PANELS.

All of the station switchboards are also located on this floor. The alternating current switchboard has 15 panels of blue Vermont marble 7½ ft. high. The panels are divided up as follows: Three generator panels; one exciter panel, containing the instruments and switches for both exciters; two main station panels for indicating the total output of the station; three arc-circuit panels; three feeder panels for outlying districts, and three panels for feeders to the sub-station. The panels are equipped with the usual switchboard instruments and appliances, all of which were built by the General Electric Company. All the instruments, including the ammeters, are supplied through transformers mounted on an angle-iron framework located 7 ft. back of the switchboard, so that there is ample space for inspection and working between the transformer bank and the switchboard.

About 650 of the arc lamps for street-lighting service are supplied from the constant-current transformers mentioned above; these lamps are of the enclosed-arc series type. The series-arc lighting circuits also contain about 450 series incandescent lamps of 75 candle-power each. The arc-light circuit panels are of the usual plug type and extremely simple in arrangement; Fig. 6 gives a front view of the three panels, and Fig. 5 is a diagram of the connections. It will be observed that each transformer supplies two distinct lighting circuits normally connected in series with each other but independently controllable. The three bus-wires of the arc switchboard are connected, of course, to the bus-bars of the main alternating-current switchboard, a diagram of which is shown by Fig. 9. The main bus-bars are in duplicate, as the diagram indicates.

The railway switchboard is of black enameled slate, containing two generator panels and eight feeder panels, which are equipped with the usual instruments and appliances, of General Electric manufacture.

The alternating-current primary lines which supply that portion of the city outside of the fire district are carried on poles in the ordinary manner, and the 2300-volt primary current is reduced to 115 volts by transformers at suitable intervals.

THE SUB-STATION.

The sub-station, from which the direct-current lines radiate, is located about 1¼ miles from the main station and within 100 ft. of the electrical center of the district supplied. The building is 30 ft. x 150 ft. and three stories high. Its equipment consists of a battery of Chloride accumulators; three 400-kw. General Electric two-phase rotary converters; six 250-kw. three-phase-two-phase General Electric air-blast transformers, and the necessary switchboard equipment. Part of the storage-battery plant and all of the transformers and converters are located in the basement of the sub-station. On the first floor is the remainder of the storage-battery plant and the general office of the company; there are mezzanine galleries in this story, on which the switchboards are located. On the second floor is the remainder of the company's offices, and the third floor is used for a stock room, meter-testing room and repair shop.

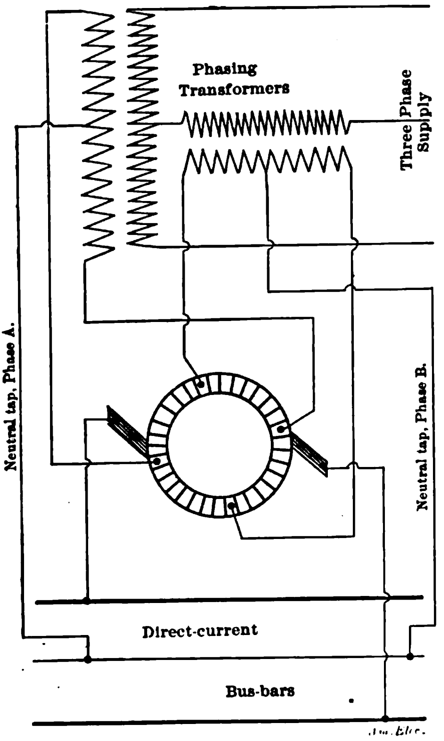


FIG. 7.—METHOD OF BALANCING THREE-WIRE SYSTEM.

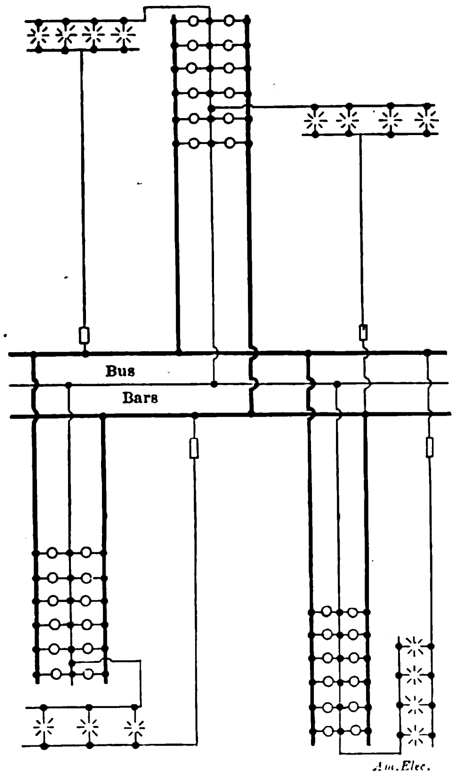


FIG. 8.—DIAGRAM OF SPECIAL ARC CIRCUITS.

The storage-battery plant comprises 150 Type H. chloride cells, of which 50 are end-cells. The battery has a one-hour discharge rate of 2720 amperes at a minimum e.m.f. of 240 volts; the tanks have reserve space for an increase of 50 per cent in the number of elements. There are six 2000-ampere end-cell switches, each having 30 points. The three-phase-two-phase transformers are equipped with dial switches which regulate the secondary voltage from 160 to 240 volts; this enables the direct-current voltage of the rotary converters to be varied from 240 to 360 volts. The terminals of the rotary converters, as the voltage would indicate, are connected to the outer bus-bars of the three-wire distribution. The neutral bus-bar is connected through switches to the center of the secondary winding of the transformers which supply the converters. This arrangement is very similar to the well-known Westhouse arrangement for operating a three-wire system from a single direct-current dynamo by the addition of an inductance coil tapped into the armature winding and connected at its middle to the neutral wire. The connections of the neutral bus-bar and transformers are shown in the diagram of the sub-station switchboard wiring, Fig. 10, but the principle is more clearly illustrated by the detail diagram, Fig. 7. The neutral transformer switches are generally open and any unbalancing of the system is taken care of by the battery.

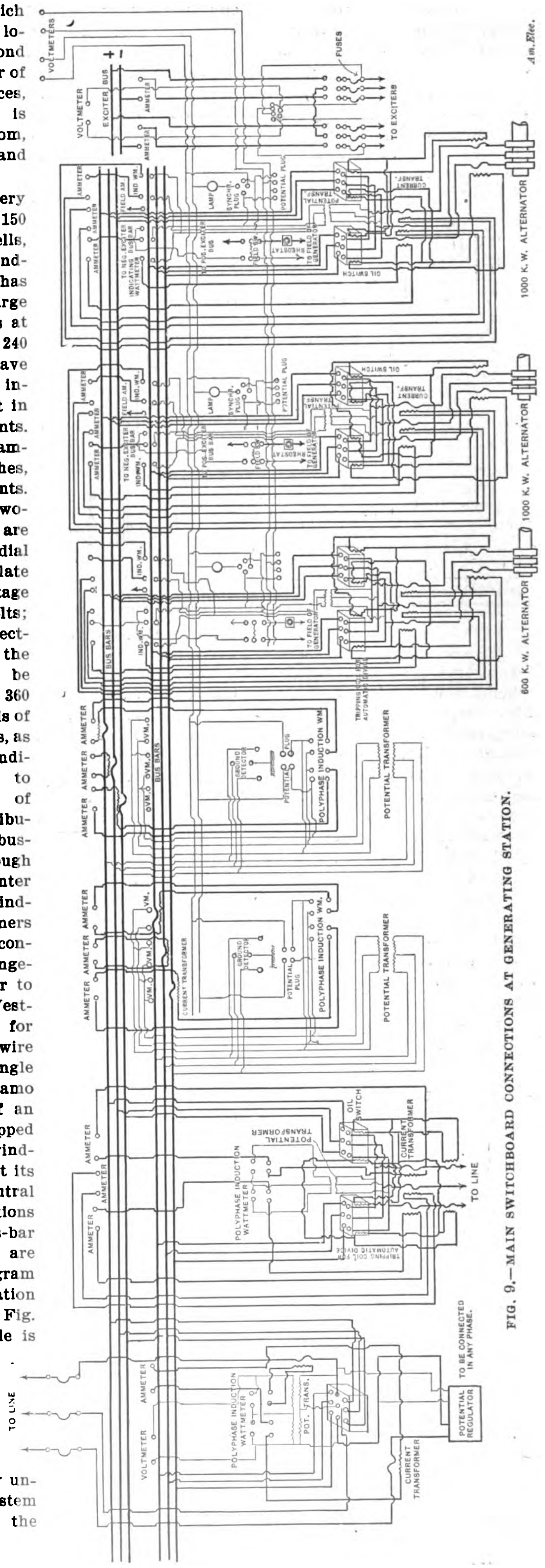


FIG. 9.—MAIN SWITCHBOARD CONNECTIONS AT GENERATING STATION.

There are three positive and negative bus-bars on the switchboard, one pair being designated the "main" busses, the second the auxiliary busses, and the third the "charging" bus-bars. The storage battery is normally floated on the system but, as the diagram shows, it can be connected up in any manner desired with relation to the rotary converters. The dial switches which adjust the secondary voltage of the transformers are operated by means of small direct-current motors, shown conventionally toward the right of the diagram. The controlling circuits of these machines are carried to double-pole double-throw switches on the switchboard panels, which connect the motor armatures with the direct-current mains in either direction.

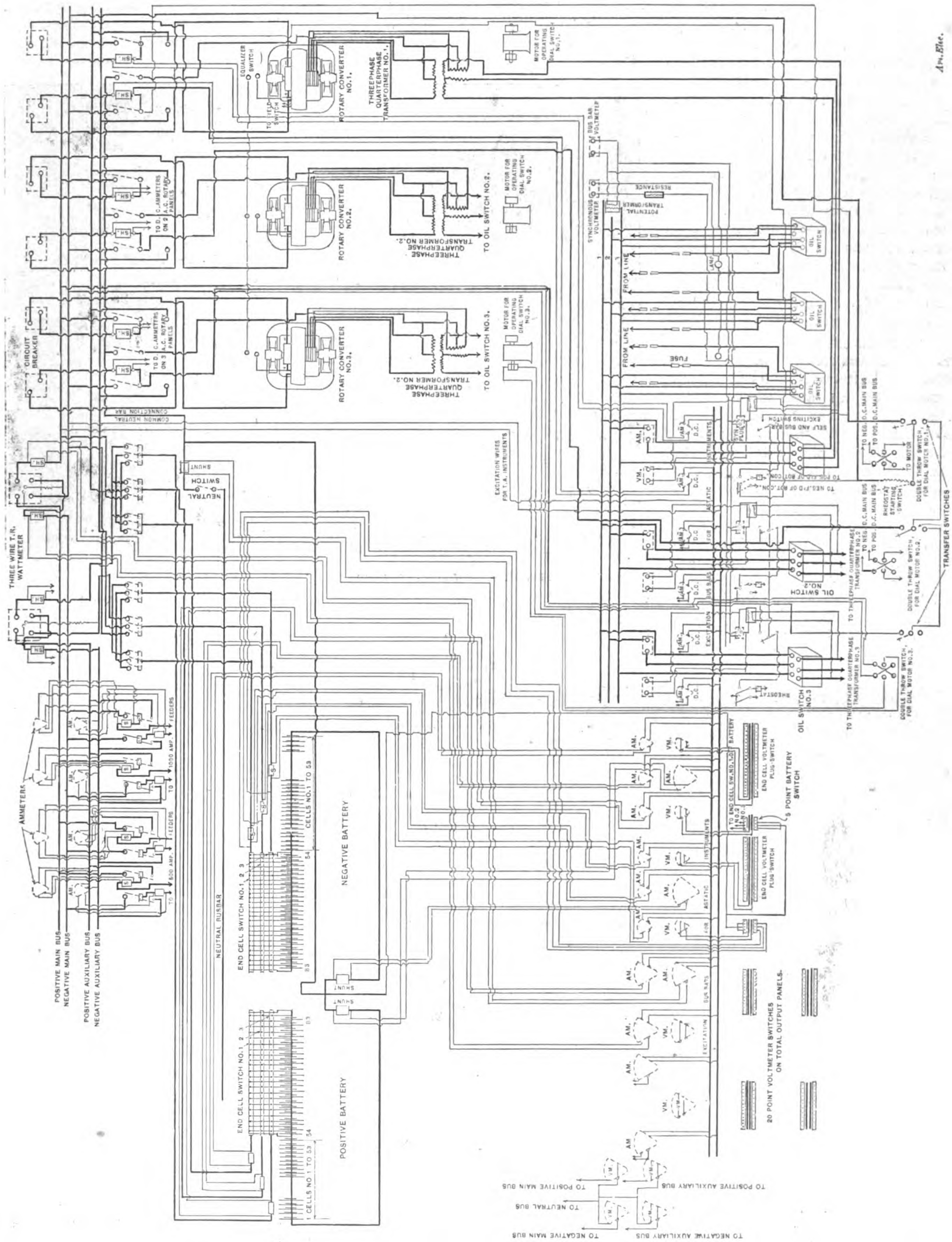


FIG. 10.—SWITCHBOARD CONNECTIONS AT SUB-STATION.

In the fire district there are about 100 arc lamps for street-lighting purposes, and these are constant-potential enclosed arcs taking 5 amperes, and supplied by special circuits from the direct-current bus-bars of the sub-station. The arrangement of these circuits is rather unusual and is extremely simple and convenient. The neutral wire of the general three-wire system is grounded, and one terminal of each of the constant-potential lamps is connected to the general grounded neutral; the other terminal is connected to a special circuit ~~wire which~~ goes to the sub-station and is connected by means of a single-pole switch to one of the outer bus-bars of the three-wire system. There are four of these single-circuit wires, each supplying 25 lamps. This arrangement obviously renders it unnecessary to carry both of the arc-circuit wires back to the sub-station; Fig. 8 illustrates diagrammatically the arrangement.

UNDERGROUND DISTRIBUTION.

The underground feeders comprise eight 1,000,000-circ. mil single-conductor cables, one 600,000-circ. mil cable, three 300,000-circ, mil cables and one No. 0000 cable, all paper-insulated and lead-covered; these connect the distributing mains with the sub-station. Besides these there are two three-conductor cables with No. 0000 conductors, paper-insulated and lead-covered, which constitute the trunk lines between the main generating station and the sub-station. All of the mains are single-conductor No. 0000 cables, rubber-insulated and lead-covered. These are used only for the outer wires of the three-wire system, the neutral conductor being an ordinary weatherproof wire thoroughly grounded.

The service wires from the main lines to the individual consumers' premises have been restricted to four sizes of wire, namely, No. 6, No. 3, No. 0 and No. 0000.

The underground conduit consists of 37,500 trench feet, aggregating 219,000 duct feet, of single-duct vitrified-clay conduit 3 ins. in diameter, manufactured by the H. B. Camp Company, Akron, Ohio; there are from 2 to 36 ducts per conduit. The conduit is laid on a bed of concrete 4 ins. thick and the sides and top are covered with concrete 3 ins. thick. Each row of ducts and their joints are laid in Louisville cement. This amount of conduit practically covers the entire fire district.

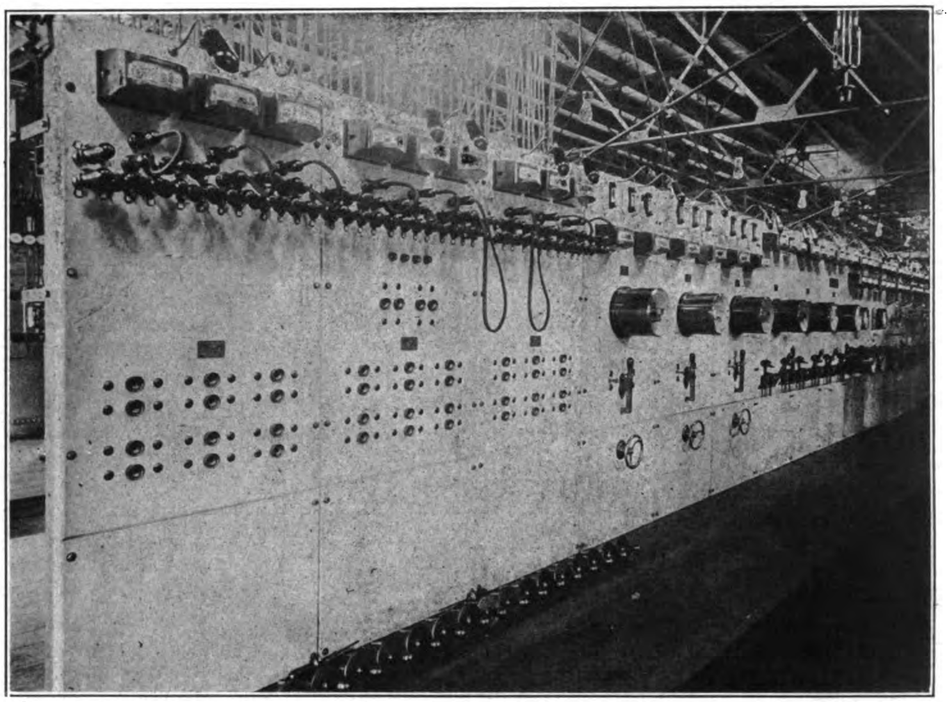


FIG. 12.—VIEW OF SWITCHBOARD SHOWING ARC LIGHT PANELS.

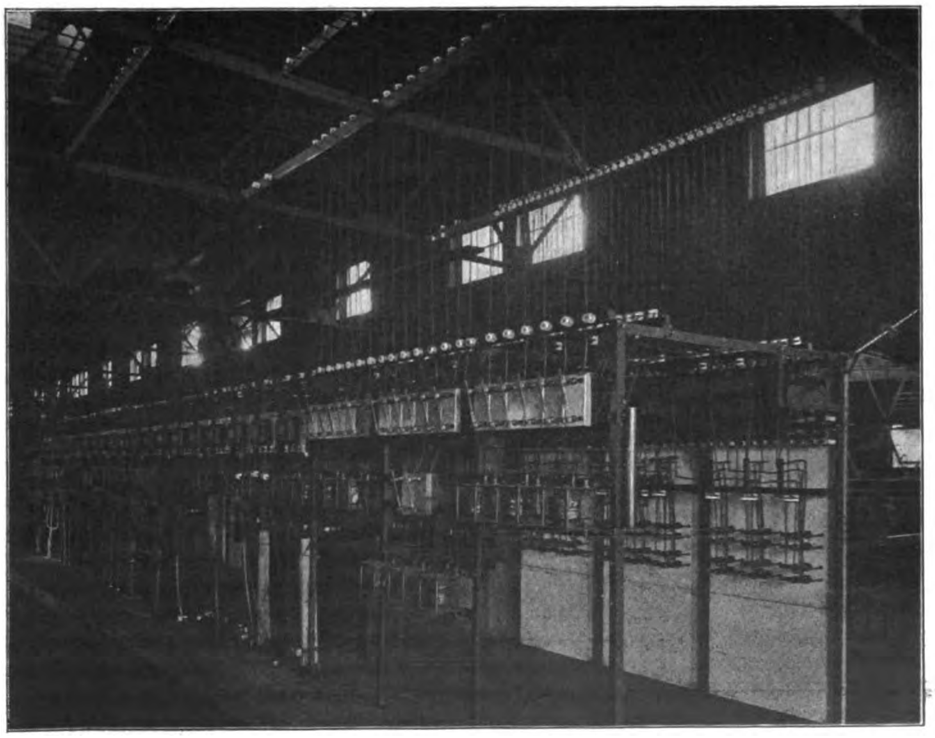


FIG. 11.—REAR VIEW OF POWER-HOUSE SWITCHBOARD.

At each cross-street intersection is a manhole of standard size, 6 ft. square by 8 ft. deep, constructed of hard red brick and Portland cement; the foundations of the manholes were built on a 6-in. bottom. Each manhole, where possible, is ventilated and drained to the nearest sewer, and where it was not possible to drain the manholes they were built water-tight. Distributing or service boxes have been built along the lines of the conduit to provide for customers between the intersecting streets. These service boxes are 24 ins. x 30 ins., plan area, the depths depending altogether upon the depth of the conduit below the street surface, which naturally varies with the obstructions met with in the street. Only the two upper ducts of each line of conduits are carried into a service box, the others passing beneath the box with 3 ins. of concrete between. All service boxes are drained to the manholes. The service boxes are practically of the same construction as the manholes, except that they are not ventilated or drained to the sewers direct.

All the manholes, except nine on a line running from the extreme western end of the Edison system to the main station, contain either a main junction box or a feeder junction box. Feeder junction boxes have been placed at the terminus of each 1,000,000 and 600,000-circ. mil feeder. The remainder of the manholes contain main junction boxes. These junction boxes are of cast iron, absolutely waterproof, manufactured by the General Electric Company, and are all double-pole, the neutral wire not entering the junction box at any point. The lead-covered cables enter the junction boxes through gun-metal stuffing boxes, the packing consisting of a triple wrapping of jute. The main junction boxes have 12 openings, providing for 6 sets of 2-wire mains. The feeder junction boxes have 14 openings, allowing for 6 sets of 2-wire mains and the two legs of the 600,000 or 1,000,000-circ. mil feeder. The service wires are carried to the consumers' premises in iron pipe.

The old plant of the Georgia Electric Light Company having comprised an overhead alternating-current system for incandescent lights, a direct-current series arc-light system and a 500-volt direct-current system for power, the change necessitated rewiring every customer's premises and making connection with the new underground mains, and the substitution of 220-volt motors for all of the 500-volt machines which were in service at the time of the change. These, however, were only the least of the manifold difficulties attending the remodeling of the plant. During the transition period the difficulties of operation were enormous; some conception of the disadvantages under which the plant was operated may be formed from the fact that there were in operation simultaneously at one period the old 1200-volt 125-cycle alternating-current service, the new 2300-volt 60-cycle alternating-current service, the old direct-current series-arc lamps fed from Thomson-Houston machines, the new alternating-current series arcs and direct-current constant-potential arcs, the old commercial power circuit at 500 volts, a 250-volt direct-current three-wire system for power and lights, and the ordinary railway service. When one takes into consideration the fact that the complete change was made from the old plant to its present form without a single station shut-down, and without discontinuing any customer's service for more than an hour and a half, it will be realized that a tremendous amount of skill and energy must have been brought to bear upon the problem, by both the consulting engineers and the Georgia Electric Light Company's operating force. The work of remodeling the plant was supervised by Messrs. C. N. Black and J. W. Sylvester, of Ford, Bacon & Davis, according to plans approved by Mr. H. M. Atkinson, president of the company.

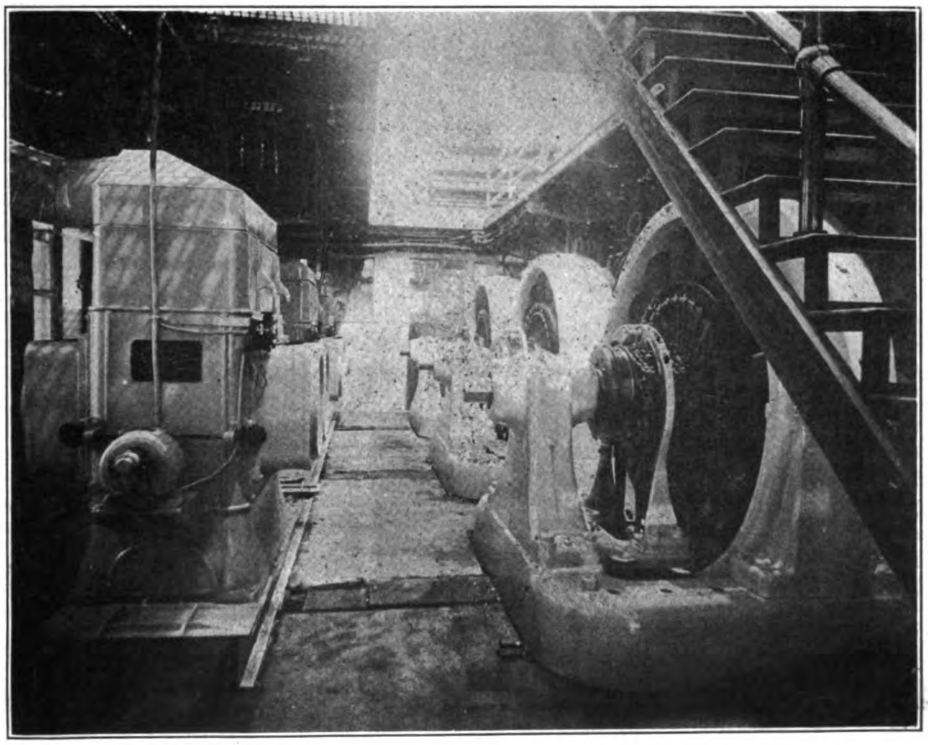


FIG. 13.—REGULABLE STEP-DOWN TRANSFORMERS AND ROTARY CONVERTERS.

TRANSFORMERS.

BY A. S. M'ALLISTER.

Almost the only advantage over the direct-current system that is possessed by the alternating-current system lies in the ease with which a high voltage for transmission may be converted to a lower one for use at the receiving apparatus. Since the receiver voltage cannot be materially altered by the adoption of either system in preference to the other, it follows that where alternating current is used for transmission, means must be provided for lowering the voltage at the receiver end. Where economy in transmission demands an e.m.f. above that for which alternators can be successfully insulated—at present about 12,000 volts—the voltage at the generating end of the system must be increased to the value of the line voltage.

As an apparatus for converting an alternating pressure of one value to that of another, nothing has been found more satisfactory than the modern transformer. Even where the nature of the service requires the use of rotary converters, with almost no exception transformers must be used to decrease the line voltage to that of the converter. A proper appreciation of the construction and performance of transformers is therefore essential to a thorough knowledge of an alternating-current system for any use whatsoever.

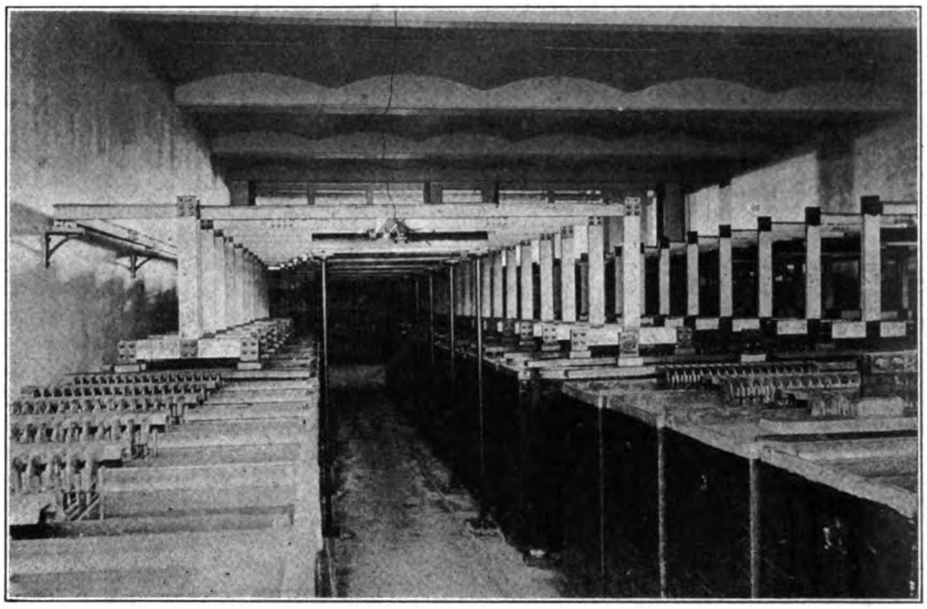


FIG. 14.—VIEW OF STORAGE BATTERY END-CELL CONNECTIONS.

A thorough mathematical analysis of the actions and reactions of transformers would require more space than it is the intention to allot here to the subject. Since also the subject has been so frequently treated from almost as many different points of view nothing new could be expected to be added to the present knowledge, while the mathematical analysis can be found in any modern text book on the subject. For the purpose of this discussion a glance at the behavior of the transformer built according to modern well-defined practice is considered sufficient.

A constant-potential transformer consists essentially of three parts; the primary coil, in which flows the alternating current from the line; the core of magnetic material, in which is produced an alternating magnetic flux by the current in the primary coil; and the secondary coil in which is induced an e.m.f. by the change of magnetism in the core which it surrounds. To assist in the understanding of the various actions of the transformer, ignore for the moment the resistance and reactance of the primary coil and the effect of hysteresis and eddy currents.

With the full line voltage impressed upon the primary coil and the secondary coil on open circuit, the effect on the primary coil and the magnetic core will be the same as though the secondary were not present. The primary e.m.f. is fully counterbalanced by an e.m.f. generated in the primary coil by the rate of change of magnetic flux within the coil, the amount of which flux may easily be obtained from the number of alternations, the e.m.f. and the number of primary turns. Since the path of the magnetic flux has in any case an appreciable reluctance, a magnetomotive force is necessary to drive the lines through this reluctance. This m.m.f. is supplied by current through the primary coil, of such a value that the ampere-turns produce the m.m.f. demanded.

Assuming a sine wave of impressed primary e.m.f., it is evident that the rate of change of magnetism must be greatest when the e.m.f. is greatest; also, when the e.m.f. is zero the rate of change of flux must also be zero. Now, since for constant reluctance the flux is proportional to the current, the rate of change of current must be a maximum when the e.m.f. is a maximum, and when the e.m.f. is zero the current must experience no change in value. The current which flows must, therefore, at each instant have a value such that its rate of change will be proportional to the e.m.f.

Without further proof it is plain that for sine waves the current must be 90° displaced from the e.m.f., and since it must produce a magnetism to generate an e.m.f. in the primary coil in opposition to the impressed e.m.f. it must reach its positive maximum after the primary impressed e.m.f. has passed through its maximum—that is, it must lag behind the primary impressed e.m.f. by 90°. With reference to power consumed, therefore, the magnetizing current is entirely wattless.

Now let us consider the secondary. Under the condition of no magnetic leakage, the secondary coil surrounds the total alternating flux produced in the core by the primary current. There is, therefore, generated in the secondary coil an e.m.f. proportional to the product of the number of its turns and the rate of change of magnetism which it surrounds. In each turn there will be generated an e.m.f. equal to that in each turn of the primary coil. The total e.m.f. of the secondary coil will be the product of the number of its turns by the e.m.f. of each turn of the primary coil.

Now suppose the secondary closed through a resistance and assume the secondary circuit to be entirely non-inductive. There will flow through the secondary coil a current in a direction to oppose the changing magnetism producing it. It will tend therefore to decrease the magnetism in the core. But in order to counter-balance the primary impressed e.m.f. there is required a certain definite number of magnetic lines, and a current will flow in the primary, tending to balance the demagnetizing effect of the secondary current. These primary and the secondary currents flow so as to directly oppose each other—that is, they are 180° apart.

Since the secondary current is in phase with the secondary e.m.f. (by assumption) and the secondary e.m.f. is directly opposed to the primary e.m.f., *this* primary current is in phase with the primary e.m.f. The total primary current is made up of a magnetizing component (Cm) lagging 90°, and a power component (Cp) in phase with the impressed e.m.f. The value of the total is, therefore, the square root of the sum of the squares of these two currents. ($C = \sqrt{Cp^2 + Cm^2}$). The primary power factor is the quotient of the power component divided by the total current ($p = Cp \div C$), while the primary lag is that angle whose cosine is the primary power factor.

In this connection it may be of interest to state that, although for a given resistance the loss due to the sum of two currents is greater than the sum of the losses due to the currents considered separately, the loss in the primary resistance due to the magnetizing current is a constant and does not increase with increase of primary current. This is due to the fact that the magnetizing current is always in quadrature to the power current. Thus, if $Cm^2\ R$ equals the loss due to magnetizing current alone, and $Cp^2\ R$ equals the loss due to power current alone, the sum of the losses considered separately is $[Cm^2 + Cp^2]\ R$ which is also equal to the loss due to the total primary current.

The above discussions are for an ideal transformer working under ideal conditions. Actual operating conditions will now be considered. If the secondary load is inductive, the secondary current will lag behind the secondary e.m.f. and the primary current, which must oppose the secondary, will lag equally behind the primary e.m.f., causing the total primary current to lag somewhat more than before. If the secondary has a capacity load, the secondary current will lead the secondary e.m.f., which will result in causing the total primary current to come more nearly into phase with the impressed e.m.f. or even to lead the primary e.m.f. In other words, the character of the secondary load is transmitted to the primary winding.

In any practical transformer the secondary resistance is not negligible. Its effect can, however, be best accounted for by considering the secondary coil to have no resistance and treating its actual resistance as being external to the transformer but within the transformer terminals. It is plain that the observed terminal e.m.f. will be less than the actual internal generated secondary e.m.f. by the amount of drop across the secondary resistance—taken in proper phase relation.

The self-inductance of the secondary coil arising from magnetic leakage can best be treated in a similar manner; that is, as though the secondary had no self-inductance but that the load current were run through a choke coil, having a self-inductance equal to the actual secondary self-inductance, situated external to the secondary coil. The primary resistance and self-inductance can be similarly treated. It is sufficient here to state that the magnetic leakage has an effect similar to inserting choke coils external to the transformer windings and may be so treated.

Hysteresis, which is due to magnetic inertia, makes itself most felt as a heating loss in the core. It appears thus as a power component of the primary current. Hysteresis loss varies as the 1.6 power of the density of magnetism and as the number of reversals—that is, it necessitates the expenditure of a certain amount of energy each reversal. In an ideal transformer having constant core magnetism under all loads, the hysteresis loss is constant when the alterations are constant. The absolute value of the hysteresis loss depends upon the quality of the magnetic material forming the core and upon the volume of the core.

The loss due to eddy currents in the core appears externally similar to that due to hysteresis. It varies, however, as the square of the product of the density of magnetism, the number of alterations and the thickness of the plates forming the core. In any given transformer its absolute value depends upon the conductivity of the plates and the volume of the core, and may therefore, be considered constant when the pressure and alternations are constant.

Due to the fact that as the transformer becomes loaded a portion of the impressed pressure is used up in overcoming the resistance and self-inductance of the primary coil, the amount of pressure to be counterbalanced by the counter e.m.f. induced by the core magnetism is lessened with load, so that the core losses, which depend upon the density of magnetism, decrease somewhat as the transformer is loaded.

Since the losses due to hysteresis and eddy currents and the exciting current copper loss demand energy at all loads, even with the secondary on open circuit, the primary current must have a power component, so that the total primary current can never lag 90°, though in transformers having low core losses, the lag at no load approximates this condition more or less.

In the discussion above it has been assumed that the reluctance of the magnetic path was constant and found that, with a sine wave of impressed pressure, the exciting current wave was also sinusoidal.

The reluctance of any known magnetic material is not constant for different degrees of magnetization, and with ordinary transformer core plates, operated at high densities, the reluctance may be considerably greater when the magnetism is at a maximum than when the magnetism is at a lower value. In addition to this increase of reluctance with density, the reluctance for any given magnetization is greater when the magnetism is increasing than when it is decreasing, on account of magnetic inertia.

Now, we have found that, with a sine wave of e.m.f. to be balanced by an e.m.f.

due to rate of change of magnetism in the core, the change in magnetism must follow a sine curve. At each instant, the magnetizing force must have a strength sufficient to drive the required number of lines through the reluctance of the core at that same instant. With constant reluctance, the magnetizing force would vary with the magnetism—that is, would follow a true sine curve. With a variable reluctance the magnetizing force must depart from a true sine form in direct proportion to the reluctance at each instant.

Therefore, when the magnetism is on the increase, the magnetizing current will be greater than indicated by a sine wave, while, with decreasing magnetism, the current demanded will be less than shown by a sine wave; and at maximum magnetism the current required for excitation will be greatly in excess of that which would have been required for a reluctance of the core equal to that at low magnetic density. It is thus evident that in practical transformers, where the reluctance is not constant, the magnetizing current does not follow a true sine wave of value but is distorted by the variation of reluctance.

This distortion is usually attributed wholly to hysteresis. That a major portion of such distortion may be quite independent of the hysteresis is shown by the fact that the increase of reluctance with saturation is entirely distinct from the phenomenon of magnetic inertia, which is true hysteresis.

The increase of reluctance at maximum magnetism causes the exciting current wave to be peaked, while hysteresis causes the exciting current to reach its zero value sooner than otherwise, during both the increase and the decrease. The resultant exciting current, therefore, leads the magnetism by reason of hysteresis and is peaked by reason of magnetic saturation. The actual wave of exciting current can be resolved into its components, a true sine wave of equal effective value, and higher harmonics, of which the third is the most pronounced.

It was shown previously that the core magnetism must at each instant have such a rate of change that the e.m.f. generated in the primary coil exactly equals such portion of the impressed e.m.f. as has not otherwise been balanced. With a sine wave of pressure to be balanced, the core magnetism will follow a sine wave of value and the secondary internal generated e.m.f. will also have a sine form, or, more generally, the secondary wave of e.m.f. must have the same form as that of the impressed primary e.m.f.

The distortion due to hysteresis and magnetic saturation affects directly only the wave of primary exciting current and indirectly the total primary current. If a current is drawn from the secondary, an exactly similar current must flow in the primary coil, and if there are no distorting influences external to the transformer itself, this primary current will have a sine form of value for a sine wave of impressed e.m.f. The total primary current will be distorted by the distortions of the exciting current, but since the exciting current must retain its form and value for all loads, constant internal pressure assumed, the relative distortions will be small when the transformer is appreciably loaded.

As already stated, the best method of treatment of primary local reactance and resistance is to consider the primary coil to be free from resistance and reactance and that situated external to the transformer windings was the actual primary impedance, the primary terminals being so connected as to include both the windings and the impedance. With a constant pressure at the primary terminals any drop across the primary impedance, due to current in the primary coil, will lessen the internal transformer e.m.f. If the primary current fluctuates the internal e.m.f. will fluctuate also. In this way a distorted primary current wave causes the secondary to have a slightly distorted e.m.f. wave even though the primary e.m.f. wave be truly sinusoidal.

The next point for discussion is the inherent regulation of the transformer. For this purpose the most logical method of analysis is to consider the primary and secondary coils to be without impedance, and the magnetic lines set up by the primary to link completely with the secondary, external to each coil being connected a choke coil having an impedance equal respectively to that of the primary and secondary coils. Under any given condition of service such portion of the primary impressed e.m.f. as is not used up in overcoming the primary impedance is transmitted without loss to the secondary coil. The apparent secondary e.m.f., however, will be less than this amount by the e.m.f. of the secondary impedance, taken in proper phase relation.

Though, with a given impedance, the drop due to a certain value of current is always the same, the apparent drop depends upon the phase relation of the current and the e.m.f. A lagging current drawn through a reactance causes a drop at the receiving end, while a leading current of equal value through the same reactance causes an increase of receiver voltage; and if the reactive component forms a sufficient portion of the impedance a leading current may cause an actual increase in the apparent receiver voltage. Therefore, a leading current drawn from the secondary may cause the delivered e.m.f. to be greater than the internal transformer e.m.f., and since the character of the secondary load is transmitted to the primary, the total current in the primary, if leading, may cause the internal e.m.f. to be greater than the impressed.

That a leading secondary current tends to decrease the ratio of transformation of a step-down transformer needs no further proof, and the effect of a lagging current, or of one in phase with the e.m.f. to increase such ratio, is also apparent from the above explanation. The regulation of a transformer depends upon the impedance of the transformer coils and the character of the load. In general, the regulation is better for transformers of large output than for smaller ones, a regulation as high as 1 per cent being realized in some recent transformers of 1875 kilowatts capacity.

In any given transformer the regulation can be improved by decreasing either the resistance or reactance of the coils. The resistance component of the impedance can be lowered only at the expense of additional copper. The reactive component, which depends upon magnetic leakage, can best be lowered by dividing the windings up into separate coils and closely interspersing the primary coils between those of the secondary. Since adequate insulation must in each case be provided between the primary and secondary windings there is a limit beyond which it is not advisable to further divide the coils and introduce insulation between the divisions.

EFFICIENCY.

Efficiency is the ratio between the output and the output plus the losses. If for each load the losses are known, the efficiency is easily determined. The three principal sources of loss are the core loss, the primary copper loss and the secondary copper loss. The core loss is due to eddy currents and hysteresis, which are constant for constant internal e.m.f., but in general, except for capacity loads decrease slightly as the transformer is loaded.

Hysteresis loss can be reduced only by decreasing either the density of magnetism or the volume of the core, both of which decreases soon reach a limit in any practical transformer. The loss due to eddy currents varies as the square of the thickness of the laminae. These laminae are coated with japan, which serves to insulate the separate plates sufficiently to prevent a cross flow of current between them. As the oxide and japan require an appreciable portion of the total space when the laminae are very thin, the space available for active lines is reduced in a given cross-section, so that, for a constant number of lines through the core, the actual magnetic density is increased by the presence of insulation when the laminae are sub-divided.

Since hysteresis increases with increase of density and eddy currents also increase with increase of density, other determining factors remaining the same, it is plain that a limit to sub-dividing the plates is reached beyond which further decrease in size of plates will actually increase the total core losses. It has been shown by Prof. Bedell and others that the most efficient thickness of transformer plates in this respect lies between 10 and 15 mils. Methods of manufacture dictate the use of as thick plates as practicable, and modern practice has almost accepted 14 mils as standard thickness of transformer plates.

For a given transformer the copper loss depends entirely upon the current in the primary and secondary coils. Since to transmit a given amount of energy requires a larger current when the power factor is low than when high, energy can be most efficiently transmitted by the transformer when the power factor is unity.

Assuming constant internal e.m.f. at all loads, the total transformer loss is made up of a constant loss and a loss varying as the square of the currents. With non-inductive load the increase of copper loss with load is quite independent of exciting current which we have found produces a constant loss at all loads. The efficiency will therefore be a maximum for that load at which the variable losses equal the constant losses.

Transformers designed to run continuously at full load should have the point of maximum efficiency occur at that load. For most systems the transformers must operate a major portion of the time on light loads and reach full or overload for only a relatively small time. For such service the core loss is the determining element for the efficiency, while the copper loss is of relatively small moment.

The loss in a transformer appears as heat in the windings and core, which must be dissipated as fast as generated in order to prevent excessive rise in temperature. Small transformers can conveniently be cooled by radiation and convection in the surrounding air. With a given rise of temperature, the energy thus dissipated varies as the area of surface exposed. Within limits, the capacity of a transformer varies approximately as the weight. With a given material of definite shape, the external area varies as the 2/3 power of the weight. As the capacity increases, the surface increases more slowly, so that large transformers, if self-cooled, would become much warmer than small ones.

It is customary to supply some auxiliary cooling medium for all indoor transformers of greater output than 10 kilowatts. For this purpose oil has been found well adapted, while its excellent insulating and puncture-repairing qualities render its adoption further desirable. In use, the oil, which completely surrounds the transformer proper, is held in a retaining case corrugated to increase the surface exposed to the air. When the loss in the transformer necessitates it, the oil is further cooled by the circulation of water in pipes immersed in the oil. Another common method of artificially cooling transformers is by means of a blast of air. Where a large number of transformers are in use, one motor-driven blower can be arranged to supply air to the whole equipment.

◆

Engines for the Rapid Transit Power House.—The engines of the New York Rapid Transit Railway power house will be Allis, of the combined horizontal and vertical type, like those for the Manhattan power house. They will be rated at 7500 horse-power each at the most economical point of cut-off, and will be capable of operating continuously under a load of 11,000 horse-power each.

Water Cooling Towers.

THE USE OF COOLING TOWERS.

BY B. FRANKLIN HART, JR.

The economy of a condensing system is so well known that a device successfully furnishing a constant and reliable quantity of cold water to a condenser, and that without appreciable cost, where a natural water supply is either lacking entirely, or is of such a character that its use is attended with damage to pumps and condenser, must interest all steam users. The cooling tower absorbs the heat in the circulating water discharge, sending the latter back to the condenser sufficiently cooled to produce good vacuum results. In conjunction with a surface condenser it reduces the cost of water about 20 per cent as compared to the water consumption in a non-condensing system. The air-pump discharge (condensed steam) becomes the boiler feed-water, and the only water lost is that due to evaporation in the tower, which amounts to about 2½ per cent. This means that power plants may be located with a single eye to expediency, and not at the end of a long line of expensive water-front property simply to get a water supply.

Plants already in operation, using circulating water drawn from muddy streams carrying grit and sand that continually cut out the pump pistons and cylinders, will avoid these annoyances by using a cooling tower, since the water, after a trip through the system, becomes entirely free from impurities of this kind. This is equally true with the use of mine or well water, where trouble is caused by deposits of carbonates of lime and magnesia. In climates where ice forms during the winter season, the cooling tower becomes a guarantee against shutting down during freezing weather. Plants located where water systems are available simply buy the small "make up" water necessary at meter rates.

The principle upon which the cooling tower operates, expressed in a few words, is simply the spreading of the circulating water in the way best calculated to bring the greatest surface in contact with the greatest quantity of air, so that evaporation may take place quickly and effectively. In actual operation the water coming from the condenser in a heated condition, when exposed to the air is enveloped in a coating of vapor, which is carried away by the air currents in contact with its surface. This vapor is continually replaced and carried away by successive contacts with fresh quantities of air. Each cubic foot of air has a vapor-carrying capacity which is governed by the percentage of moisture already in it, or, as it is called, its relative humidity. When the air is dry, or comparatively so, its heat-absorbing efficiency, measured by its vapor-carrying capacity, is high as compared to a similar quantity of air at or near the point of saturation.

In other words, the cooling tower does its best work when the surrounding air is dry. Radiation also does part of the cooling, particularly during the winter season, as does also the contact of the cool air with the heated water; but the bulk of the work is due to evaporation, since the evaporation of a pound of water carries off about 1000 heat units. The main point, then, in the design of a successful cooling tower is to distribute the water so that the greatest amount of surface is exposed, and to provide the necessary circulation of air. To this end various means have been employed. At first, all the manufacturers of modern cooling towers obtained the necessary circulation by the use of fan blowers. Indeed, the fan tower, so called, is still recommended for cases where the quantity of heat to be removed is great, and where the duty is especially severe in the hot summer months. But the cost of power necessary to operate the fans, and the wear and tear due to moving parts resulted in the elimination of the forced fan draught, and in the production of the natural-draft fanless towers. These are of two types, called the flue and the open. In the flue tower the tank containing the water-distributing device is carried up sufficiently high to induce draught enough to supply the required quantity of air. This design is intended for location between buildings or in back yards, or on the roof of a low building surrounded by higher ones. Another feature which makes this type sometimes favored in large cities is the absence of precipitation, which, in some cases, might prove a nuisance.

The open fanless tower now in successful use, not only dispenses with the fans, but does away with the tank structure entirely. The tower is open on all sides to the air and the natural currents are utilized. Where sufficient ground area is available this type of tower is largely recommended. It is simple in construction, easy of access, and requires a minimum of attention.

In locating a cooling tower, the matter of available space is the first consideration, although the question of piping must also be kept in view. Where ground area is expensive, as in large cities, roof installations are advisable.

Cooling towers may be used in conjunction with either jet or surface condensers, but with the jet system an additional pump must be employed to deliver the discharge from the air pump to the top of the tower. The surface condenser is preferred when the tower is located on the roof, since the discharge and suction columns balance below the tower, making the work of the pump that due solely to the height of the tower itself.

The work of the cooling tower in power-plant practice consists of abstracting sufficient heat from the circulating water to reduce its temperature enough to use it again in the condenser. This means a reduction from about 120° F. to 80° F. when a vacuum of about 25 ins. is to be maintained. Vacuum results are measured aside from the air displacement by the quantity ~~and temperature~~ of the cooling water. When the temperature is low the quantity required is correspondingly small. The question becomes one of proportion, and the ratio of water to the exhaust steam to be condensed is determined by the following formula:

$$\frac{H - t_1}{t_1 - t_2} = R$$

where H = the total heat in the exhaust
t_1 = temperature of discharge,
t_2 = temperature of suction,
R = Ratio of water to exhaust steam.

This formula shows that 25.7 lbs. of cooling water are required to condense each pound of exhaust steam to maintain a vacuum of 25 ins. when the temperature of the circulating water is 80° F.

Upon the quantity and terminal temperature of the circulating water is based the area of surface necessary in the tower to cool the water. The apparatus will handle to good advantage only that quantity for which it is designed. Greater quantities lessen its efficiency. For best results the attendant should regulate the speed of his pump in order to deliver the proper quantity of water required to meet the varying conditions.

The volume of air delivered to the towers is also a variable quantity, and the speed of the fans is regulated accordingly. The temperature and relative humidity of the atmosphere are the elements encountered at this end of the problem. When these are both high, the volume of air must be great. The maximum figures, and those on which the air delivery is based, are 95° F. in the shade, with 80 per cent saturation. These conditions, being extreme, are seldom met with, and are then but of comparatively short duration; but anything approaching this calls for the highest fan speed. This should vary from 250 r.p.m. in a 10-ft. fan to 670 r.p.m. where a 4-ft. fan is used. Fans are driven most advantageously by an independent engine or motor, so that the speed may be regulated at will. Motors are used in many installations, and make very compact and economical fan drivers; they should be arranged for changes of speed. Shafting, when located handily, is often used. In the open tower nature supplies the air currents, and the manufacturers provide an increased surface, the combination doing the work required.

As to the operating expenses of a cooling-tower condensing system, as compared with the cost of running non-condensing, let us take the case of a proposed power plant to be located where a natural water supply is wanting, and where the cost of hydrant water is great. For a 500-h.p. steam unit the steam consumption would vary from 22 to 23 lbs. per indicated horse-power per hour in a compound non-condensing engine, to between 13 to 15 lbs. in a condensing engine of the same type, showing a saving of from 8 to 9 lbs. of steam, or about 1 lb. of coal per hour per horse-power in favor of the condensing unit. Against this should be charged the amount of steam necessary to run the pumps and fans (where a fan tower is used), which averages about 3½ to 4 per cent of the total horse-power output. These figures show a net saving of over 30 per cent, and must not be confounded with the percentage of economy in running an engine condensing that was designed to run non-condensing. In this case the saving is about 20 per cent in favor of the condensing system.

Concerning the advisability of cooling-tower installations under various conditions of environment, it might be stated generally that since the cooling tower is an artificial scheme (making use, however, of natural functions) to supply what nature has failed to do, it should only be used where a bountiful supply of water is not easily available. But further investigation justifies modifying this statement. In laying out a proposed electric railway, the location of the power-house becomes one of the principal questions. To get the benefits of a condensing system the plant must be placed on the banks of a river or a large body of water, unless recourse is had to the cooling tower, in which case location becomes a matter of general expediency.

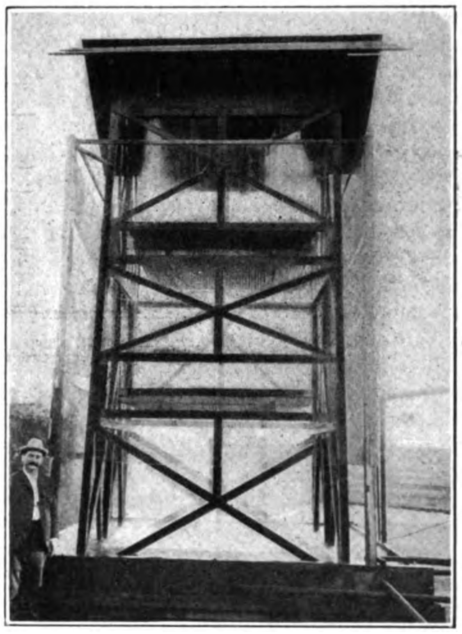


FIG. 1.—ACME COOLING TOWER.

When water is taken from wells, it has been found that the cost of operation, where a reciprocating pump is necessary, exceeds that of running a centrifugal pump delivering to a cooling tower, since the steam consumption per hour per horse-power in the former case is far greater than in the latter. Where a river-level recedes to a very great extent during part of the year, as is the case in many western rivers, and the water of the river is gritty and muddy, a cooling tower is decidedly advantageous, and enterprising engineers are making such installations in old-established plants as well as in new ones.

If canal water is used, and there are periods when the water is drained for repairs, or freezes, the cooling tower becomes a very important adjunct, eliminating all risks of shut-down and the necessity of non-condensing operation while the water supply is cut off.

COMMERCIAL FORMS OF COOLING TOWER.

BY C. W. OBERT.

The cooling tower, which has done so much to make feasible the operation of steam engines condensing in places where cooling, or injection, water would ordinarily be too expensive, or too scarce, is an apparatus that has comparatively recently been brought into use. The principle upon which it operates is that of the well-known property of liquids of absorbing heat when undergoing evaporation. The hot discharge water from the condenser is merely put through a process in which especial facilities are offered for a portion of it to evaporate, and the absorption by the evaporating portion of the heat required by it for conversion into latent heat of evaporation, is sufficient to remove the surplus heat from the remainder of the water and thus cool it down to a temperature at which it can be used over again.

Any process by which sufficient open air evaporation could be effected might serve for this purpose, but the cooling tower is arranged to hasten the rate of evaporation to an extent unattainable by any purely natural process. The method used in all cooling towers is, in general, the agitation of the water and the exposure of a great amount of its surface to the air, which is the condition most conducive to the evaporation of liquids; the fundamental differences between the various towers in general use are found only in the mechanical means employed to effect the necessary agitation and surface exposure.

The Acme cooling tower, built by the Acme Water Cooling Tower Manufacturing Company, Weehawken, N. J., employs for its surface-exposing action a simple gravitational spray or sprinkling effect. In the view of this tower, Fig. 1, it may be seen that there are shallow pans, or tubs, arranged shelf-like one above the other from the top to the bottom of the tower. These pans have rows of perforations disposed symmetrically over their bottoms, so that they resemble large sprinklers, and the action of the water during its passage through the tower, after entering from the pump discharge into the top pan, is that of simply sprinkling down from one pan to the next, until it reaches the receiving tank at the bottom. To prevent the water from flowing from the perforations in solid streams, deflecting plates are placed upon the bottom of the pans, one under each row of holes, as shown in Fig. 2. These give the individual streams a spreading or spraying tendency; and the deflecting plates are bent toward the middle of the pan, so as to throw the water toward the middle of the tower. The successive pans are arranged so that the rows of jets are at right angles to each other, which gives better distribution to the falling water, and the pans, being arranged upon angle-iron cross-piece supports, may be turned around or removed entirely, at will.

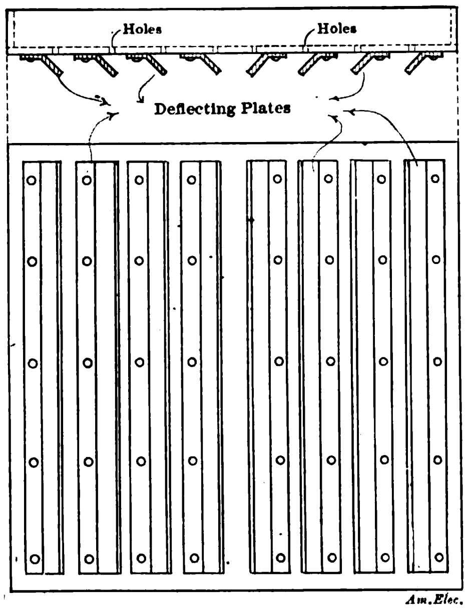


FIG. 2.—DEFLECTING PLATES, ACME COOLING TOWER.

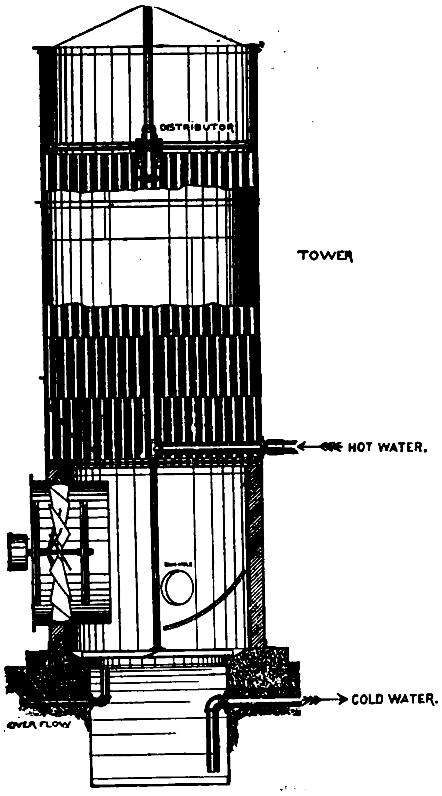


FIG. 3.—WORTHINGTON COOLING TOWER.

Fine wire netting is wrapped around the tower frame so as to enclose the water course and catch any spray that would otherwise be blown outside the tower in case of a strong wind; the spray collects on the netting and drains from there down to the receiving tank below. It will be noted that no means are employed in this tower to effect the agitation or surface exposure of the water besides that of gravity in the sprinkling action.

It is stated that water is cooled down to from six to ten degrees below that of the atmosphere without any trouble. An interesting incident occurred with one of these towers in use; it was found that it was cooling the water more than was necessary for the particular work in hand, so the intermediate pans were taken out of the tower, when the water was found to be cooled sufficiently by simply falling from the top to the bottom pans of the tower with nothing intervening.

The Worthington cooling tower, built by Henry R. Worthington, New York, is specifically an enclosed tower, all types of this make being entirely closed in with either a steel or brick casing. Fig. 3 gives a sectional view of a Worthington tower, from which an idea may be had of its construction. The tower is open at the top and there is an open space at the bottom above the receiving tank; between these two open spaces are several layers of short cylindrical pieces of tiling, set vertically and entirely filling the body of the tower. The lower layer of tiling rests upon a grating support for ease of access by air from below, and the tiles in each layer, which are packed as closely together as possible, are so arranged with regard to those in the next layer below that the walls of each individual tile come opposite the air-spaces of those directly below; that is, the joints are broken so as to break up the currents of air and water in order to cause a more thorough contact between them. Thus the water and air both undergo a new distribution each time a new layer of tiles is encountered, and the water, entering at the top and flowing down over the surfaces of the tiles, exposes a very great evaporating surface.

The water is discharged from the pump delivery onto the tiles through a rotating distributor, of which a plan is shown in Fig. 4. It consists of a series of radial arms of pipe projecting from a hub pivoted on the top of the discharge pipe; this hub delivers the discharge water out into the radial pipes, which have numerous little tube jets projecting out in one direction, so that as the hot water flows out therefrom the reactive effect causes the pipes and hub to revolve after the manner of a "Barker's mill." Owing to the proper location of the tube jets on the arms as well as their revolving motion, every portion of the tile filling receives its proportion of the falling water, a thorough distribution being thus effected.

The Worthington tower, on account of being shut in from the outside air, requires an artificial means of air circulation. In the type shown in Fig. 3, the necessary circulation is furnished by a blower fan, as shown near the bottom, driven by a motor or other suitable power; these towers are also made so as to operate without the use of a fan, the air circulation being caused by a vertical extension of the tower casing into a chimney, which induces a natural draft in a manner similar to a boiler chimney. Fig. 5 is a view of the Worthington chimney-draft tower, with a section of the casing cut away so as to show the interior. It is exactly the same as the fan-draft type of tower, except that the fan is removed from the lower air space and the chimney, or flue, extension added to the casing above the top of the tile filling. The tile filling and the self-revolving water distributer at the top are exactly the same and their functions are the same as in the fan-draft tower.

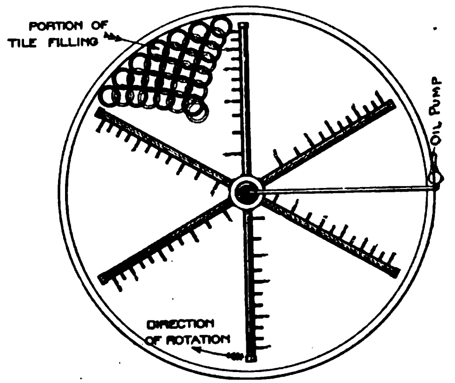


FIG. 4.—ROTARY DISTRIBUTOR, WORTHINGTON COOLING TOWER.

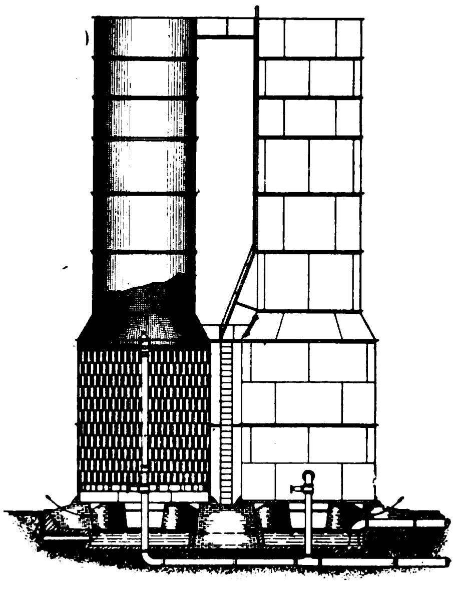


FIG. 5.—WORTHINGTON CHIMNEY-DRAFT TOWER.

The fanless type of tower has the advantage, like the Acme tower, of not requiring any expenditure of power to provide air circulation; there is another advantage in that the rising warm vapors condense on the inside wall of the chimney and flow back down into the cooling tower, although, in order to get a good strong air circulation it is necessary to have the vertical extension or stack of considerable height, for the same reason that boiler chimneys must be high in order to generate a strong furnace draft. On the other hand, the fan-draft type of tower has the advantage that it may be forced beyond its rated capacity if necessary; by speeding up the fan above its usual speed the tower may be made to cool a much greater quantity of water than usual, in case of an overload or other emergency.

When it is desired for any reason to place the tower upon a roof, or in any other position where it is necessary that its weight shall be as low as possible, the earthenware tiles of the Worthington tower are replaced by galvanized-iron open-ended cylinders which, by reason of their lightness, reduce the total weight of the tower to a minimum, and as the cans are placed vertically in layers in the tower, in exactly the same manner as are the earthenware tiles, the area of evaporating surface remains the same.

Still a different type of cooling tower is manufactured by George J. Stocker, St. Louis, Mo. This differs from the Worthington tower chiefly in the form of the interior filling of the tower. It is an enclosed tower, and is made for both fan draft and chimney draft. The filling, over which the hot condenser-discharge water flows for spreading out into large surface area, consists in this tower of wooden strips arranged horizontally across the tower to form a sort of lattice work. The edges of the strips are beveled off to a point and they are all set up edgewise, as shown in Figs. 6 and 7, which diagrams show also the criss-cross arrangement of these strips in layers one above the other. Some layers are crossed at right angles and some at 45 degs., so that when they are assembled in the tower they appear as shown in the plan view of the lattice-work, Fig. 8. This lattice-work filling occupies the entire section of the tower from a level just above the air space above the receiving tank, up to the base of the chimney, or to the top of the tower if fan-draft is used. The water is evenly distributed upon the lattice-work by a system of funnel-shaped troughs, and trickles down in a thin film over the cooling surfaces formed by the strips; it is broken up at every layer of the boards and re-distributed, so that it is thus brought into the most intimate contact with the cool air that rushes up through the tower from below.

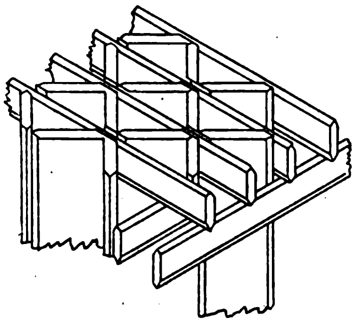


FIG. 6.—DETAIL, STOCKER TOWER.

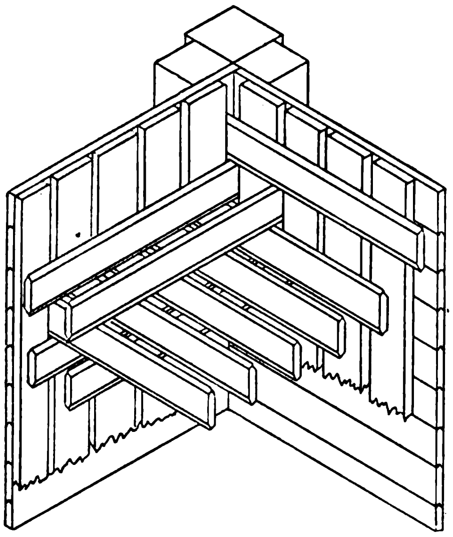


FIG. 7.—DETAIL, STOCKER TOWER

The same differentiation between the fan and fanless towers applies here as in the case of the tower previously mentioned. The tendency seems, however, to be toward the installation of the fanless tower where sufficient room is obtainable and the conditions of operation will permit. If the conditions of the service are not too exacting, the saving in power alone, disregarding the saving of water condensed from the moist vapors in the chimney extension, will undoubtedly give a decided preference to the fanless tower.

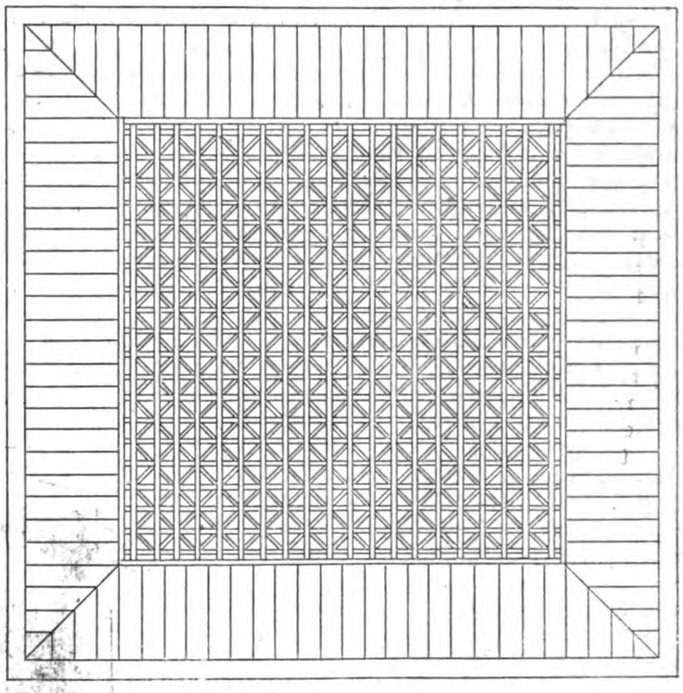


FIG. 8.—PLAN OF LATTICE WORK, STOCKER COOLING TOWER.

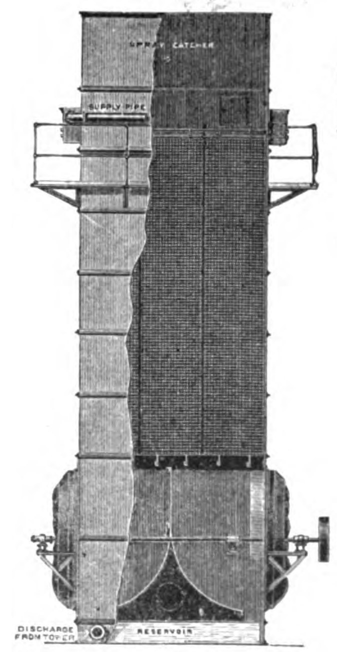


FIG. 9.

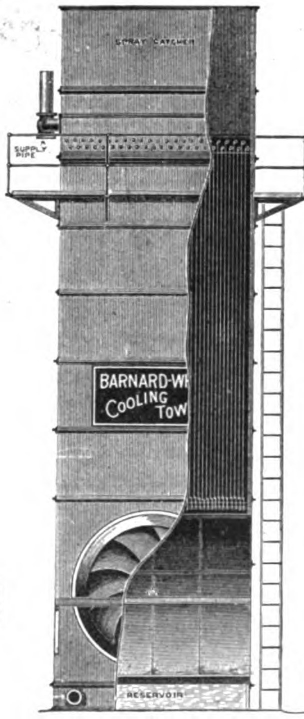


FIG. 10.

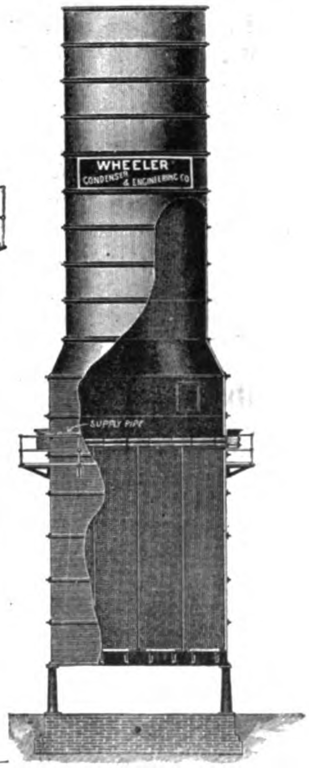


FIG. 11.

The Barnard cooling tower, built by the Wheeler Condenser and Engineering Company, New York, embodies an interesting construction for obtaining the requisite amount of surface for evaporation. This tower is made in both the fan-draft and the chimney-draft forms of the encased tower type, and also in the open fanless type. The mechanical means by which the agitation and surface exposure of the heated water is obtained is, however, the same in all three forms of Barnard tower. It consists of causing the water to drip lengthwise down vertically suspended woven-wire mats, the water being evenly distributed and subdivided over the upper edges of the mats so that it flows uniformly over and through them, causing the entire area of both sides to act as an evaporating surface. These mats are made from No. 19 steel wire, woven into a netting of No. 5 mesh and galvanized after weaving; they are suspended vertically in the tower by hooks from their individual distributing pipes, as is clearly shown in the views of the tower, Figs. 9 and 12.

The hot condenser discharge water is pumped up through a delivery pipe into a trough located just above the tops of the mats, and from this trough the water runs into distributing pipes which deliver it to the mats. The water runs down these mats in a thin film, the uneven nature of the netting causing an agitation and continuous redistribution of the flow, and finally it drips off at the bottom into a receiving tank with which the tower is provided, as is usual in all towers.

Fig. 9 is a side view of the enclosed fan-draft tower with the casing cut away to show the arrangement of the mats, and Fig. 10, which is an edge view of the same tower, shows how the mats are arranged side by side. In Fig. 9, the troughs into which the supply pipes discharge are shown on each side at the top, and also the arrangement of the fans is shown. The two fans are on the same shaft and run in the same direction, but their blades are so shaped that they both force air inward, and it passes upward between the mats and out at the top, having performed its evaporative function. Fig. 11 is a view of the fanless, or chimney-draft, style of the enclosed tower. It differs from the fan type of tower only in that it is entirely open at the bottom and has a flue extension at the top to induce a draft, the water after leaving the mats simply draining into the receiving well below. In both of these enclosed towers the casing is of steel plates strongly braced.

In Fig. 12 is shown the fanless open type of tower, in which the arrangement of the mats is somewhat different from that in those just described. The mats are arranged radially around the central stand-pipe, as shown, the stand-pipe delivering the hot water to a circular trough at the top, out of which the distributing pipes are tapped. The group of mats is entirely exposed to the air for evaporation, there being a tendency toward the formation of a draft in the central opening surrounding the stand-pipe, which is materially aided by a wind. The trough and distributing pipes are so arranged that any pipe and its mat may be disconnected for repairs or cleaning, or whole sections of the tower may be cut out in times of light load, when they are not needed.

The various cooling towers herein described are all capable of the arrangement for variable loads of having numerous smaller towers rather than one or two larger ones, so that as the load on the engines varies certain towers may be put into service, or stopped, as the condition of load may require. The use of several smaller towers is preferable for the reason that in cold weather the cylinder oil that is brought from the engines through the condenser by the steam is very liable to coagulate and clog up the exposing surface of the tower so as to interfere with the proper evaporation of the water; with the several smaller towers, fewer units may be used, and all of them kept running to their full capacity so as to minimize this trouble, which will also allow the idle ones to be cleaned at convenience.

In operation the cooling tower has proven to be very efficient and to require very little attention. Under ordinary conditions a reduction of temperature of 50 degs. Fahr. in the discharge water is very easily accomplished and a considerable greater reduction is possible. The humidity of the air, of course, affects the capacity of the tower, as the evaporative power of air is much less when it contains a great deal of moisture. However, towers properly proportioned have proven capable of lowering the temperature of the water sufficiently for practical purposes under the worst possible conditions of humidity. The loss of water through the evaporative process for refrigeration varies from 2 to 6 per cent, according to the humidity and temperature of the air, and other conditions.

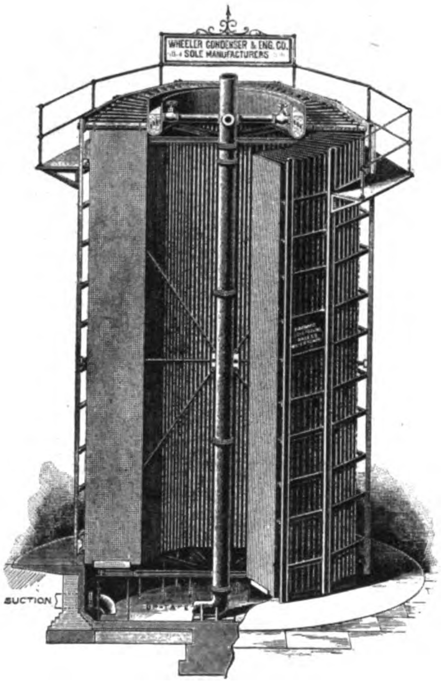


FIG. 12.—FANLESS, OPEN TYPE, COOLING TOWER.

The cooling towers described in the foregoing represent the types at present in general use and are all patented in respect to their methods of surface exposure. While no suggestion of substitution for any of these is intended, an account of the use to which a make-shift cooling tower was recently put may be interesting. A New Jersey electric light plant that runs engines condensing had been dependent for its condensing water upon a small pond of water, covering about two acres, but after an increase in the plant it was found that the water in the pond did not cool off fast enough to enable the necessary vacuum in the condensers to be maintained. A rough, inexpensive tower with several platforms was erected in the middle of the pond and the air pump discharges were piped upward to a point several feet above the top platform. The mere splashing of the water as it is discharged and runs down over the platforms, a distance of about 40 ft., causes sufficient evaporation to cool the water down about 35 degs. Fahr. The water in the pond has since cooled with sufficient rapidity to enable over 1000 horse-power of engines to be run condensing.

THE NEW CHIEF ENGINEER.

BY E. D. WILLIAMS.

There is, perhaps, no more critical stage in the experience of a central-station engineer, with regard to both his reputation and his success, than when he is transferred to and given charge of a new plant. Whether it be new to him merely or new in design and construction, he is sure to find novel conditions and practices, and is apt to lose much of his self-satisfaction unless he is of such temper as to believe that nothing new can be good.

It is a severe test of an engineer's abilities, either as a steam and electrical expert, or as a man of common sense and good judgment, to place him in a strange field, giving him authority and responsibility, and letting him shift for himself. Many an engineer has failed to stand the ordeal, and has reluctantly acknowledged that his opinion of his own abilities was excessive, in the light of a substantial promotion.

How shall the engineer take hold of his new plant so as to most rapidly and thoroughly become familiar with the equipment and conditions of operation? He must learn two things: namely, the service expected and the means at his disposal to render such service. To secure the first information he can begin by consulting the records of daily output of the plant. The variations in total output should first be considered—variations between the different months of the year, between the different days of the week, and hours of the day. This will enable him to anticipate and plan for Sunday schedules, for increased output in the busy season, for opportunities to lay off and clean boilers, repair engines and pipe lines, or to revise the station wiring.

These "total-output" figures having been secured and analyzed, a more thorough study should be made of the records, in order to subdivide and apportion the product in its various classes; high-potential alternating current for lighting, moderate-voltage direct current for power, 550-volt street-railway service, and series arc-light supply. The hourly, daily and monthly variation of each of these should be considered, and reference made to the generators used. Questions will arise, such as: "What provision is made for breakdown in each case?" "How can the varying demands for current be balanced so as to make the total station load more uniform?" "Have we sufficient equipment in each department for the certain proportionate increase of the busy season?" "Is every one of the departments a profitable one to operate, from the central-station standpoint?" In many small plants records are not kept in such complete form as to give this information. In such cases it must be obtained by personal observation for a sufficient period of time. The trouble and labor involved in doing this will be well repaid.

....Electric Company.

CENTRAL STATION DAILY RECORD.

Day of Week.......................... Date..........................190..

Reading of Water Meter at close of day................gallons. Coal consumed..............lbs.

No.	Equipment.	Time, A. M.												Time, P. M.											
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
1	Boiler, 66″ x 18′ 0″..............																								
2	" 66″ x 18′ 0″..............																								
3	" B. & W..................																								
4	" B. & W..................																								
5	" 60″ x 18′ 0″..............																								
1	Pump, 8½″ & 4½″ x 6″.........																								
2	" 6″ & 7″ x 10″............																								
3	Vacuum Pump, 10″ & 12″ x 18″..																								
4	" " 8″ & 10″ x 16″..																								
5	Centrifugal " 8″.............																								
1	Engine, 18″ x 36″............																								
2	" 22″ x 42″............																								
3	" 18″ & 36″ x 48″.........																								
1	Arc Dynamo, T. H...............																								
2	" " T. H...............																								
3	Ry. Generator, 250 KW..........																								
4	" " 300 KW..........																								
5	Alternator, 165 "																								
6	" 300 "																								

Temperature of Feed Water................

(Signed)... } Engineers.
.... }

FIG. 1.—CENTRAL STATION DAILY REPORT BLANK.

In any plant, no matter of what size, the engineer should have an accurate knowledge of what is going on during every hour of the twenty-four. A report blank that will assist in securing this information is shown in Fig. 1. Ordinarily, squares would be filled with an x mark, indicating that the particular equipment referred to is running. If left blank, the indication is that the apparatus is out of service. If a damper regulator is not used, and the boilers do not all operate at the same pressure, the square opposite each boiler could be filled with a note of the pressure carried at the time of recording. The vacuum pumps should have the number of inches of vacuum noted. Arc dynamos could be indicated by the number of lights, alternators by the rate of current in amperes. The numbers used to indicate each machine should be marked plainly on the equipment itself, and employees will soon acquire the habit of referring to apparatus by number.

The blank should be printed on heavy manila paper of rough surface, and signed by each head engineer on duty during the twenty-four hours. Indelible pencils should be provided and used in reporting. A few spare lines should be left at the bottom, so that in case of the purchase of new equipment the report can be made complete. To get the full value of this system of reporting, the total hours of service, etc., from the daily records should be compiled each month on a single sheet, ruled in squares which represent days of the month on horizontal lines and the various pieces of equipment on the vertical. A final column should be left in which the total hours of service by each apparatus, the average vacuum, steam pressure and feed-water temperature, could be entered, and at the top of the record should be a statement of the total amount of water evaporated, coal consumed, and kilowatts delivered. These total figures could be used in comparative monthly statements over a period of years, and would often throw welcome light on recurring questions.

Having obtained an intelligent idea of what is required of his plant, the engineer should study the means at his disposal. These may be grouped into the two elements, machinery and men. He will, of course, learn the names and addresses of all employees, will know who is on duty at every hour of every day, will have a list of men available for extra or substitute duty, and of applicants for employment. He will judge of his subordinates by the condition of apparatus throughout the plant, by the degree of economy in the use of fuel, oil and other supplies, by their ability to keep things running or to get them running in emergencies; by the discipline and order they maintain among their own subordinates, if there are such, and by their past record and experience. He will soon learn, if he is a reasonably good judge of character, how far he can depend on every man.

To master the inanimate equipment of the plant, the prime requisite is personal investigation. While information and assistance from others should be received gratefully, nothing should be passed until the engineer has seen and analyzed it for himself. Starting with the boilers, he should follow every steam pipe to its ultimate destination, noting all conditions tending toward a lack of economy, safety or convenience. Then he should accumulate all possible data regarding every point to which these pipe lines connect.

The diameter, length, size and number of tubes, width and length of grate, date built, date of setting, condition of external and internal surfaces and condition of brick setting, are the first points to be ascertained with regard to the horizontal boiler. The blow-off cocks should be located and the piping traced out, even if recourse to a pick and shovel is necessary. The water column piping and any other small steam connections to the boiler should be noted and analyzed, and the safety valves and steam gauges tested. No statement, whether of conditions or dimensions, should be taken for granted. At the engines some of the data to be secured are diameters and stroke of cylinders, diameter of piston rod, number of revolutions per minute, belt-wheel or fly-wheel diameter, condition of interior of cylinder and bearings, and date installed. The sizes and types of steam pumps should be also noted. From the engines and pumps the exhaust lines should be followed critically to the atmosphere and condensers. Full particulars of heaters, condensers, vacuum pumps, grease separators, back-pressure valves and the like should be obtained.

With condensers and feed pumps as starting points, the water-piping system should be studied thoroughly. The primary sources, provisions for emergencies and fire protection should all be considered. Frequently pipes are laid underground and statements regarding arrangement get hazy. In such a case, the man with the pick and shovel should be immediately summoned. If steam is used for warming buildings, the heating systems must be inspected and studied. The connections from engines to generators and the wiring system form the next step. The latter must be traced from generator to switchboards and the boards picked to pieces, figuratively. The investigation should continue to the point where the wires have left the building for good. Full data regarding instruments, switches, rheostats and conductors should be secured at this point.

With this information well digested, the new engineer should be fairly well acquainted with his plant. Unless the station is so small that he has occasion daily to operate nearly every piece of apparatus, he will find it advisable to commit the result of his investigations to paper, making a permanent sketch (not necessarily to scale) showing every piece of equipment in its relative position, noting thereon all the data he has secured and indicating all steam, water and exhaust pipe lines and wires, with the sizes, materials and fittings of each marked. Then let him view the whole as an abomination to be criticized and improved to the greatest degree possible at the slightest possible expense.

In starting on the line of improvement, those things in which the greatest saving can be effected should be started first. This usually means a prompt and persistent effort in the boiler room. The engineer may find that he has met with an unfamiliar fuel; certainly with unfamiliar firemen. He may not be an expert fireman himself, and may find it difficult to learn what is the cause of the trouble. His experience will teach him to look for dirty boilers, inferior fuel and leaks in the blow-off cocks first, but if this much is done without substantial improvement, his next step will be toward the man who is burning the coal. If this step is taken and the ordinary instructions with regard to light firing, control of feed water and draught, and care of boilers are apparently carried out without benefit, there is still one way in which the trouble can be located.

Arrange to measure the water and coal and make some tests. Try a number of boilers under varying rates of steaming, and find the most economical point. Try the same boilers at a constant rate of steaming but with different firemen. Separate the boilers and test each at various loads and as fired by different men. Get the most complete data possible under all conceivable dissimilar conditions, varying one factor—load or fireman—at a time. Having thus found as conditions of maximum economy a certain load on a certain boiler or battery with a certain fireman, manipulate the equipment and men so as to imitate these conditions, applying the principle of the survival of the fittest to all concerned. Firemen are apt to be obstinate, self-satisfied or discouraged, but in the long run no one is quicker to appreciate the blessing of fuel economy; and when once convinced that something is being accomplished in this direction there is no more faithful ally than the stoker.

Mention has been made of the advantage of testing the boilers at various rates of steaming, in order to ascertain and adhere to the most economical rate of evaporation. This must be done for each particular plant, because there is no generally accepted rule as to what is the best rate of steaming.

While these and the other questions that will occur to him in the boiler plant are being investigated, the engineer may well devote some time to the pipe lines. If he is anything of a success in his business he will have long before this inaugurated a crusade against leaks, whether in live steam, exhaust or water pipes. He will probably have also invested in some non-conducting cement for patching the pipe covering or extending it to new fields of usefulness. Here, however, is a good chance for him to show his wisdom by making haste slowly. If by a few changes in piping he can get his feed water a little hotter, or help an engine over a bad top-notch load, he had better let pipe covering alone until he has had his plans sanctioned and the work executed. Then when the piping itself is satisfactory is the time to begin cement work, and this should not be confined to the main live-steam lines, as is often the case, but should include the tops of the boilers (unless they are bricked over), the pipe fittings, flanges and valves, down to the smallest exhaust lines as far as the heaters, the heaters themselves, pump and engine cylinders, hot-water piping from the heaters to the boilers, everything in fact that contains steam or water that has not outlived its usefulness in the plant.

These two losses—leaks and radiation—are the best known, and are usually the first that are remedied. The engineer can still help the fuel statement from a piping standpoint, however. He will look over the water heating system and condensers carefully, estimating the work done by each, and balancing possible gains in one against losses in the other. He will study the arrangements and sizes of pipes; the provision for removing water of condensation before it reaches places where it may do damage, the initial steam pressure in his engine cylinders, as compared with that shown by his boiler gauges, and the back pressure on his exhaust lines. He will look jealously at every waste and discharge pipe to see if heat units are getting away unnoticed; and if oil separators, baffle plates, traps or receivers will help him, he will get those heat units back to the boiler.

His steam-using apparatus—the engines and pumps—will demand attention from the first. Are the bearings of ample size for cool running and safety, economy in oil, and minimum loss of power by friction? A wrist-pin can usually be replaced by a larger one. If the cylinder is worn and grooved until the weight of the piston is held by the rod, can the springs be set out to remedy it ? Will the cylinder stand reboring to avoid the passage of live steam from the admission side of the cylinder to the condenser? It is poor economy to run with "porous" pistons. Are the valves and seats in good condition? The indicator comes into play here and gives a clue to many of the little losses that aggregate to something of consequence—uneven distribution, drop in initial pressure, wire drawing, leaky valves, loose gear and excessive compression. The pounds will be located—the uniform ones in the bearing, the intermittent in the valve mechanism.

Possibly some of the older men at the plant may belong to that class which believes that an engine will never run as quietly when set by the indicator as when adjusted by guess and sound. If so, it is a genuine pleasure to convince them of the contrary, as well as a quicker and better way to set valves for economical engine performance. The pump rods and pistons will be examined, and new ones made if the old are given to wheezing. The valves may be giving trouble, either because of broken springs or because they are worn. A good heavy washer between the spring and the rubber may remedy this.

The belts are a good field for criticism. If in good condition, they should carry the load without slipping and without the necessity of drawing them so tight as to strain the shaft against the side of the bearing. If they have been in service for some time it is well to see that they are sound and tight at the laps. A noisy belt is a good field for the exercise of inventiveness.

The opportunities for economy on the part of the chief engineer in the steam department of the central station do not stop with care and attention to the mechanical efficiency and fuel consumption of his plant. He has still to consider two very important phases of his work—the use of supplies and the control of his men. Of all sundry supplies, the most important is oil. Nothing can be truer than that to be wasteful of oil is a mark of inexperience and inefficiency. A new man is certain to indulge in extravagance in this direction, and it is well that it should be so, as the expense of a single hour's shut-down or of one burnt bearing may be more than that of a week's supply of lubricating materials. The competent man, however, will gradually cut down the consumption of oil to a figure close to the minimum, and it is here that a habit of getting into details will tell.

The engineer should know how many drops per minute are allowable under average loading for every cylinder lubricator and wrist-pin cup. He will tell at a glance about how fast the cups are feeding. He will make every drop that he puts on the valve gear reach the exact spot where he means it to go. He will know how to make allowances for heavy loads, and when to look out for adjustments in cold weather. If he does have trouble, he will manage to keep running by shifting on another machine or by using a little cylinder oil and graphite, or in the last resort, by the hose. It is assumed that he is progressive enough to catch and filter every drop of waste oil and use it over again. The dregs from his oil separator, if beyond his resources to save, will find a welcome from the oiler of some neighboring mill, where they will make an excellent lubricant for the line shaft bearings, and prove a little source of revenue to the electric company.

For the care of other supplies—waste, towels, soap, lamps, carbons, wire, etc.—a store-room should be provided, and this kept locked; supplies should be given out only on an approved order. The consumption for each month should be kept track of and a flat refusal should be given to unreasonable demands.

A form of report that has been found useful in accounting for fuel and oil is given in Fig. 2. This is signed by the engineer in each tour of duty, and the receipts and consumption are checked by office accounts and monthly inventories. The amounts on hand are made to agree on the first of each month with the amount shown by the company's inventory, any slight discrepancy being charged or credited on the last day, and no account of that day being taken in estimating the consumption by the different engineers.

....Electric Company.

CENTRAL STATION SUPPLY REPORT.

Day of Week......................Date..........................190 .

..............................Tour.

Coal.

On hand.......................................lbs.

Received.......................................lbs.

Used.......................................lbs.

On hand at close of day.......................lbs.

Details of Receipts.

Initials.	Car No.	Grade.	Amount	
			Tons.	Cwt.
....	......	......	......	......
....	......	......	......	......
....	......	......	......	......
....	......	......	......	......
....	......	......	......	......
....	......	......	......	......
	Total received			

Oil.

Engine Oil on hand..........................gals.

" " received..........................gals.

" " used (new)..........................gals.

" " " (filtered)..........................gals.

On hand at close of day..........................gals

....

....

Cylinder Oil on hand..........................gals.

" " received..........................gals.

" " used..........................gals.

" " on hand at close of day..........gals.

....

....

Other Supplies used..

....

Supplies needed..

....

(Signed).......................................Engineer.

FIG. 2.—CENTRAL STATION SUPPLY REPORT BLANK.

The amounts on hand from day to day are estimated at the relief of shift by the relieved and relieving engineers, and they manage to agree. The receipts are entered by the chief engineer or person carrying the keys of the oil house and storeroom. The putting of this plan in operation in one plant resulted in a protest on the part of an engineer against the specified quantity of a certain commodity received, and upon investigation it was found that the amounts billed were running ahead of the amounts actually delivered, so that a heavy deduction was frequently made which would otherwise have been paid for and charged to the central station.

The treatment of his men, and his attitude to his employers by a new chief engineer, called to take charge of a strange plant, is by far the most important and difficult problem to meet. As a stranger, possibly a usurper, he will be criticized, his words and actions weighed, his very manner carped at. His statements and recommendations should, therefore, be those on which he is absolutely sure of his competence. He should make haste slowly, weighing all conditions and looking at all sides of a question before committing himself. He should make allowances for changed circumstances in comparing what is with what has been, and must be prepared to find, wherever he goes, plenty of bright, capable men. If he is prudent, he will exhaust every effort to please his immediate superior, for in any well-ordered business, while the superior gives satisfaction, the engineer will never be allowed to appeal over his head.

He must not experiment with the time or money of his employers. As an engineer, he will be expected to speak with certain knowledge of things pertaining to his department, and will gradually be trusted with regard to matters on which he will be considered to know the ground. He should, therefore, early develop the habit of combating his own convictions in order that he may get firmly grounded in correct principles and not be a party to any recommendation that the future may show to have been unwise. In giving care to details, he should determine to go at a disagreeable or difficult undertaking so as to do a better job than he would have done if the task had been easy.

There is not a central station in the country where a man should find time to be idle. There is never an hour when something cannot be done to improve the plant, and economize in its operation. There is no man, however humble his position, whose judgment is not worthy of some weight and consideration. Toward his subordinates, the engineer should act, first, so as to secure their coöperation. To start with the iron hand is pretty sure to bring ruin. A mild course at the outset will give time to study the different men so that the best ones may be held until they are over the first surliness, after which all will go smoothly.

For his own reputation, the new man will try to work out the problems that come to him in a thorough, logical way, so that when his employers ask for his report, he can give them definite conclusions. He will not go to his superiors with unhatched germs of ideas for improvement, but will keep hammering at it until he has something tangible to offer. He will remember that his worth is reassured, not by comparison with what his predecessor has done, but with what represents normal efficiency, and if he finds examples of inefficiency or incomplete efficiency set for him by those above him—direct contradictions in character from what he believes to be just—he should take care not to imitate such types but to profit by the good points of all with whom he may come in contact and to confine his errors and faults to those which are native in him.

A Modern Small Central Station.

PLANT OF THE URBANA (ILL.) LIGHT, HEAT & POWER COMPANY.

BY W. H. ZIMMERMAN.

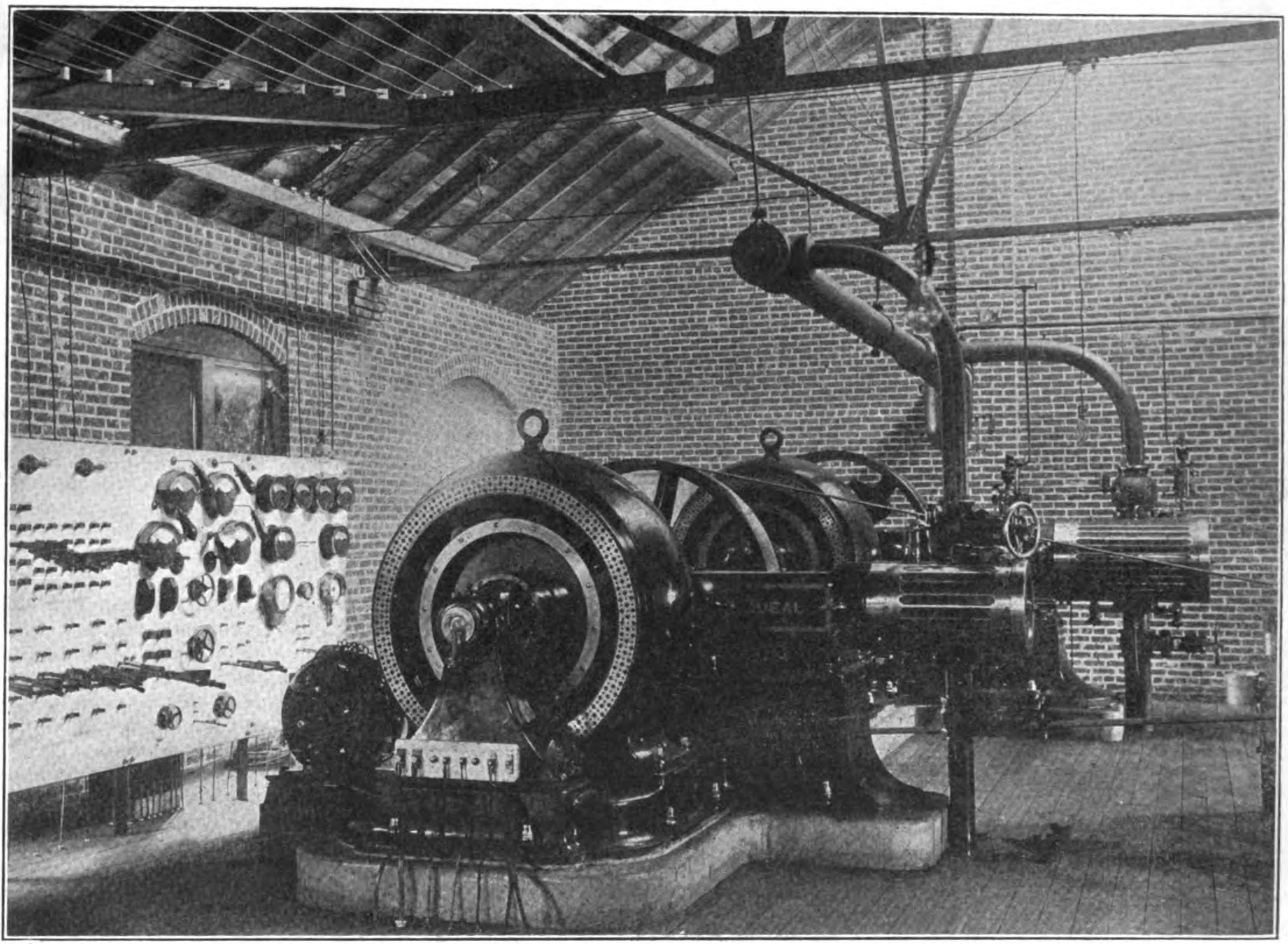


FIG. 1.—ENGINE AND GENERATOR ROOM OF THE URBANA LIGHT, HEAT AND POWER COMPANY.

The service obtained from this plant consists of arc and incandescent commercial lighting, arc street lighting, electric power and steam heating. Alternating current at 110 and 220 volts is delivered for twenty-four hours each day for incandescent lighting, arc lighting, or power, and direct current at 500 volts is supplied from 6.30 a.m. until 6 p.m. each day. Steam for heating is supplied to any part of the business district of the city during the heating season.

The power house is 108 ft. long and 42 ft. wide, built of brick and stone with steel trussed roof covered with slate, and includes the boiler room, engine and generator room, store room and the offices of the company.

It is located about two blocks from the center of the commercial lighting and heating load, and also on a lower level than nearly all of the buildings which are supplied with heat from the station. Although the location is adjacent to the Wabash Railroad yards it has been found that by arranging the plant to get coal from either of the three competing railroads the coal could be hauled on wagons and delivered to the coal bunkers at less cost than that at which it could be bought on cars without shipping competition.

The coal used is bituminous screenings, and the wagons on which it is delivered are provided with bodies having bottoms of loose planks which may be shifted so as to allow the coal to drop out, thus requiring very little time and labor in unloading. These wagons are drawn up an incline and over a trestle 10 ft. in height, the floor of which contains 2½-in. openings which readily allow the coal to pass through when dropped from the wagons. The elevated trestle is adjacent to the side of the boiler room and opposite the boiler fronts. Under this trestle is storage capacity for about 300 tons of coal, and this can be increased to 600 tons by shoveling from the wagons after the space under the trestle is full. This arrangement allows the coal to drop into the boiler room to a point convenient for firing. Heavy sliding doors, opening vertically and counterbalanced, are provided to regulate or shut off the coal supply to the boiler room as desired.

At present two horizontal tubular boilers are in use, each 72 ins. x 18 ft., but sufficient space is provided in the boiler room for future growth as the service may require. These boilers are set in one battery and are constructed without domes or dry pipes; they are designed for a working pressure of 125 lbs. per square inch, but at present the safety valves are set at 115 lbs. The boilers were built by the Murray Iron Works Company, Burlington, Iowa. The smokestack is of the guyed type, 94 ft. high and 50 ins. in diameter, made of No. 10 steel, and supported on an independent sub-base so as to relieve the breeching and boilers of all weight.

The live steam piping and the 8-in. main steam header are constructed of extra heavy pipe and fittings, with long bends connecting the engines to the header. An Austin steam separator is located in the header at the point where the first engine connection is taken off.

A Stilwell open-exhaust heater is used to heat the feed water, and is located in the pump pit in the engine room. The boilers are fed with a Smith-Vaile duplex pump, and a Penberthy injector is provided for a reserve.

There are two Ideal "Special" simple engines (A. L. Ide & Sons), one 16 ins. x 16 ins., and one 13 ins. x 12 ins., each running at 257 r.p.m. and direct-connected respectively to a 120-kw., and a 60-kw. single-phase, 60 cycle inductor alternator, built by the Warren Electric Manufacturing Company, Sandusky, Ohio. The generators are designed each for two voltages, namely, 220 and 2200 volts, the type and construction of the machines making such an arrangement very practical. The capacity at each voltage is one-half of the full capacity of the alternator, half of the armature coils being connected for the lower e.m.f. and half for the higher. Either half of the winding will carry much more than one-half the capacity of the machine, however, if the total load does not exceed the full capacity. As most of the commercial incandescent lighting service is near the station it is run on a 220-volt, three-wire system with a small investment in line copper and without the use of transformers. The three-wire system is kept equalized by means of two specially designed static balancing coils, each of sufficient capacity to take care of a continual unbalance of 5 kilowatts. These balancing coils are mounted in transformer cases, and hung on poles near the center of distribution.

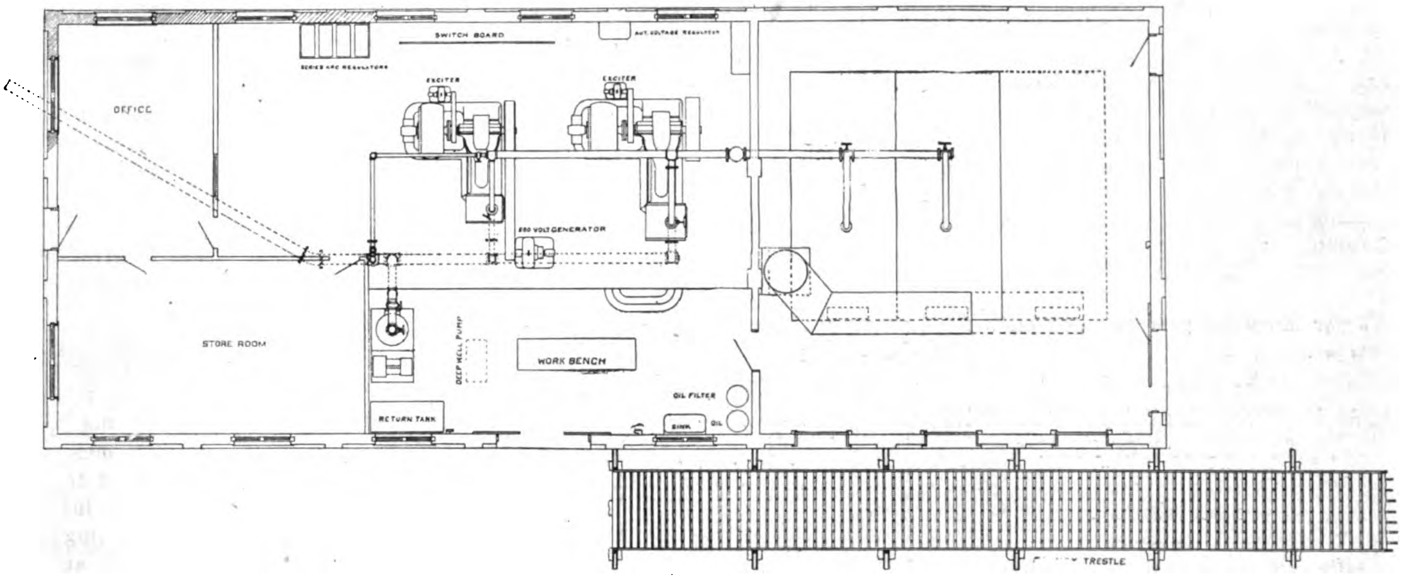


FIG. 2.—PLAN OF POWER HOUSE.

The 2200-volt side supplies the long distance distribution system of light and power and also the street lighting arc lamps, consisting of four 25-light circuits of Manhattan series enclosed arcs. Each circuit passes through a separate constant-current regulator of the reactive type, and takes current directly from the switchboard without the use of a transformer.

A 35-kw., 500-volt, direct-current dynamo, belted to the governor pulley of the smaller engine, is used for power service where direct current is required.

The switchboard consists of four marble slabs, each 44 ins. x 66 ins. Each generator panel contains a set of instruments for each voltage, as well as main switches, fuses, ground detectors and exciter switch and rheostats. One of the panels contains seven double-pole double-throw distributing switches, arranged to connect any or all circuits to either generator as desired. Synchronizers and equalizing switches are also provided and arranged to put the two alternators completely in parallel, or the 220-volt sides of the two machines may be worked in parallel while the 2200-volt sides are either idle or working on independent circuits, or *vice versa*. The fourth panel contains the 500-volt direct-current instruments and switches, an ammeter for each of the four arc-light circuits, and a recording voltmeter and a recording steam gauge.

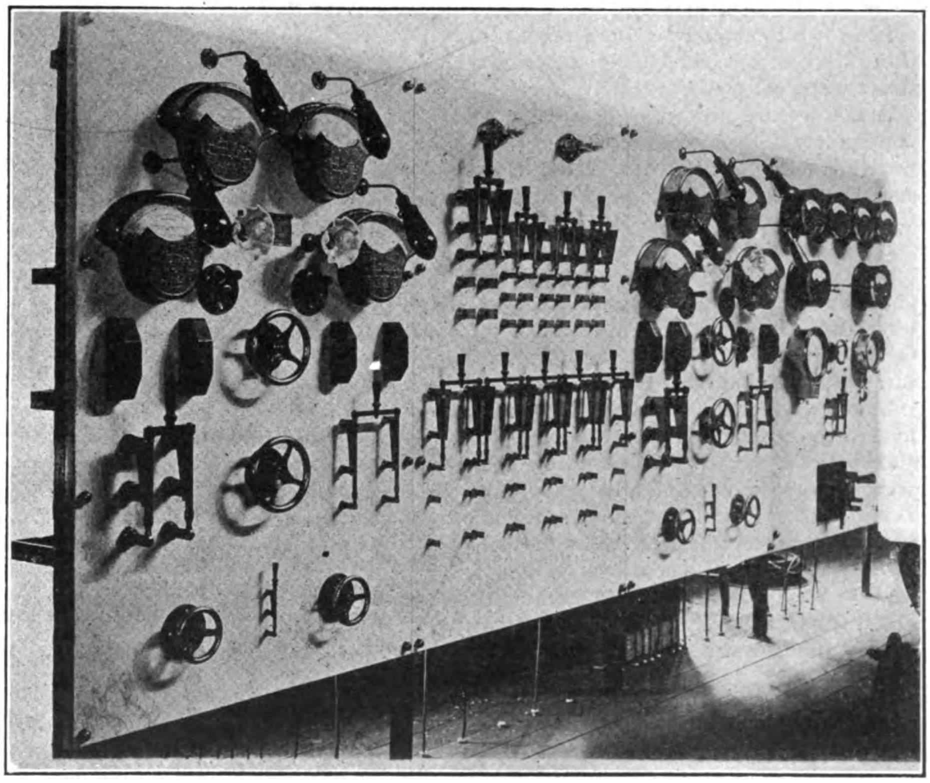


FIG. 3.—SWITCHBOARD, URBANA LIGHT, HEAT AND POWER COMPANY.

A Belknap automatic voltage regulator is used and is connected by pressure wires with the center of distribution. By this arrangement the regulation is kept within 2 per cent over the entire system. By means of two double-throw switches the regulator can be connected for service to either generator or to both.

The exhaust steam from this plant is utilized in heating the city hall, library, city fire department, county court house, county jail and several business houses, hotels, etc. The Holly system of central station steam heating (American District Steam Company) with underground piping, is used. The greater part of the water of condensation is returned by gravity through a cast-iron screwed-joint return main, to a return tank located in the pump pit. Where the water of condensation cannot be returned to the plant by gravity it is discharged from the traps directly into cooling coils, through which it circulates before passing to a waste pipe or sewer.

The rate charged for heating service is 25 cents per square foot of radiation for the entire heating season, and is based upon the amount of radiating surface in the building, regardless of whether or not it is used all or part of the time, and consumers are under contract to shut off all radiation except what is necessary to keep the building warm when properly enclosed.

The commercial incandescent and arc lighting and power is, with few exceptions, supplied on the meter basis, the company furnishing the meter without charge, but requiring a minimum bill of one dollar a month. The meter rate for incandescent lighting is 20 cents per kilowatt-hour, with discount ranging from 20 per cent to 50 per cent, according to the amount used. The rate received for street arc lamps is $75 per lamp per year less deduction for outages.

LOSS IN ECONOMY BY THE INEFFICIENT COMBUSTION OF FUEL.

BY A. BEMENT.

All technical effort tends toward a commercial achievement, and it is by this means that the value of any method or apparatus must be measured, and if any technical process has a commercial value it will surely find adoption as fast as the intelligence of the time will allow. The possibility of more economical use of fuel being accomplished by a better understanding of the combustion process, is one of these problems which must be measured by a commercial standard instead of being viewed from a distance as an abstract technical matter.

If the present prevailing practice with boiler furnaces has reached or nearly approached perfection without the aid of gas analysis, it necessarily follows that there would be no occasion for more advanced study of the matter, if otherwise it should certainly be the privilege and opportunity of the engineer or station manager to avail himself of the advantages of methods and means of determining the influence of the furnace conditions as effecting efficiency.

The performance of a steam generating apparatus is usually looked at from the standpoint of what it does do, rather than what it does not do; and a brief examination of the source of the more important heat losses with stationary boilers may be profitable. The largest and most important of these is by the chimney in products of combustion; in air which has not been used, and by combustion gases escaping unused. This loss by the chimney should never be greater than 22 per cent, but may in some cases be as low as 12 or 15 per cent; even if the justifiable loss be limited to 22 per cent, and the losses of combustion in the ash, radiation, moisture in the air, fuel carried over the bridge wall, heat lost by burning hydrogen in the fuel, etc., be placed at 8 per cent, there would be left 70 per cent for useful work, which would be a reasonable, every-day performance for an ordinarily good apparatus. How near does prevailing practice conform to this? Let the station manager or engineer put this question to himself and see how near he can answer it; not by estimating or guessing, but from actual knowledge of his own conditions. His answer to himself will show him how well he knows whether a study of the furnace performance is useful or not.

The losses, except those by way of the chimney, may be considered in a large measure as fixed losses; the loss due to unburned combustible in the ash may vary somewhat, but it is the one loss which generally receives the most attention, because the coke in the ash is readily visible. This loss, therefore, may be considered in a measure as a fixed one, while that by the chimney is the varying, as well as the largest loss.

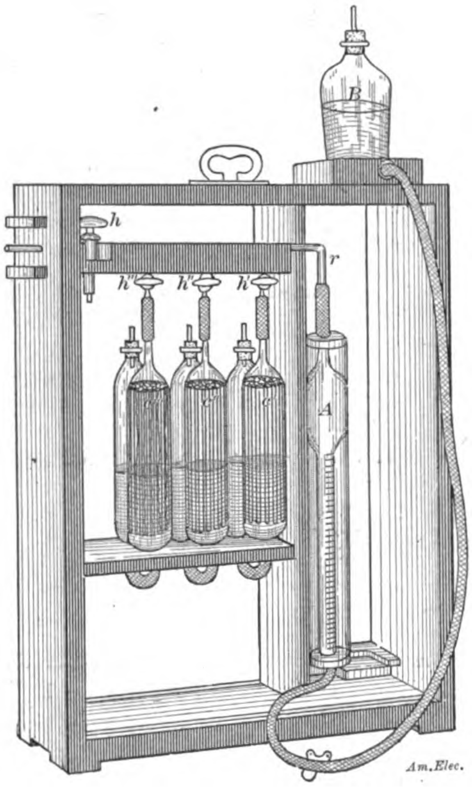


FIG. 1.—ORSATT'S APPARATUS.

The relative constituents of the escaping gases as shown by analysis, should run, for good results, between the two compositions following:

	A	B
Carbon dioxide (CO_2)	11%	15%
Oxygen (O)	8	4
Carbon monoxide (CO)	0	0
Nitrogen (N)	81	81
	100%	100%

Between these two conditions there would be a difference in heat loss with gases leaving at 600° F. of about 4.5 per cent, but if the combustion should be as follows:

CO_2	4%
O	15
CO	0
N	81
	100%

the loss would be 45 per cent.

The above compositions are with complete combustion, but if combustion is in any measure incomplete, the loss will be greater.

Let the engineer in charge of boilers ask himself how near complete is combustion in his case and what is the average per cent of carbon dioxide in the gases; his answer to himself will help him come to the conclusion whether he desires to employ gas analysis in the operation of his boilers or not. If he decides that he does, he would have a choice of several instruments.

The most convenient and useful instrument for determining the proportions of CO_2, O and CO in furnace gases is the Orsatt apparatus, sold by all chemical supply houses. This is only one of a large number of instruments designed for the same purpose but differing in some manner, but it would be the only instrument that the engineer would be justified in considering. Fig. 1 shows such an instrument. The burette, or measuring tube, *A*, contains from its zero mark at the bottom to the upper capillary end, exactly 100 cub. cm.; but its graduation (in 1/5 cub. cm.), extends only to 40 cub. cm., and ceases where the tube is enlarged. In order to guard the gas in this burette from the influences of changes in external temperature the tube is surrounded by a water-jacket closed at the top and bottom by india rubber stoppers, and provided with a white background of milk glass against which the black scale divisions on the burette are plainly visible. The bottom of the burette is connected by an elastic tube with a level bottle, *B*, which is two-thirds filled with water; the top end of the burette is connected with a glass capillary, *r*, bent at a right angle and ending in a three-way cock, *h*. This tube is protected against breakage by a wooden frame, and carries at right angles three taps, designated *h'*, *h''*, *h'''*, each having capillary tubes, and connected by inside rubber joints with three U-shaped absorption vessels, *c'*, *c''*, *c'''*, each of which is filled with a bundle of glass tubes. The vessel, *c'*, contains a solution of caustic potash and absorbs the carbon dioxide (CO_2); *c''* contains an alkaline solution of pyrogallol and absorbs oxygen (O); *c'''* contains a concentrated solution of cuprous chloride in hydrochloric acid and absorbs carbon monoxide (CO). In order to keep this latter solution in an unchanged state it is left in constant contact with copper spirals introduced into the glass tubes in *c'''*. Sticks of moist phosphorus may be used in the tube *c''* for absorbing the oxygen in place of the alkaline solution of pyrogallol, in which case the glass tubes within the absorption vessel are unnecessary.

The absorption vessels are half filled with the chemical. This is drawn up to the mark made in the capillary neck by opening the connecting tap and running off the water in the burette, *A*, for which purpose the level bottle, *B*, must be lowered. In making a test, the level bottle, *B*, is raised, the tap, *h*, opened, and the burette, *A*, filled with water to the capillary part. The outer end of the capillary tube is connected with the tube through which the gas is to be led, and the lower end of the three-way cock, *h*, with a hard rubber pump by which the air is removed from the conducting tube. The gas is aspirated by lowering *B* and turning *h* through 90 degs. The water is then run off to a point a little below zero, the tap, *h*, is closed and the gas compressed by raising *B* till the water is above the zero mark. The india rubber tube is then squeezed close to the joint by either the fingers or a pinch-cock, and after lowering *B*, water is permitted to escape by cautiously loosening the elastic tube, until the level falls to the zero mark. The tap, *h*, is then opened for an instant in order to equalize the pressure inside the apparatus with that of the atmosphere, whereupon exactly 100 cub. cm. of gas will be confined in the burette.

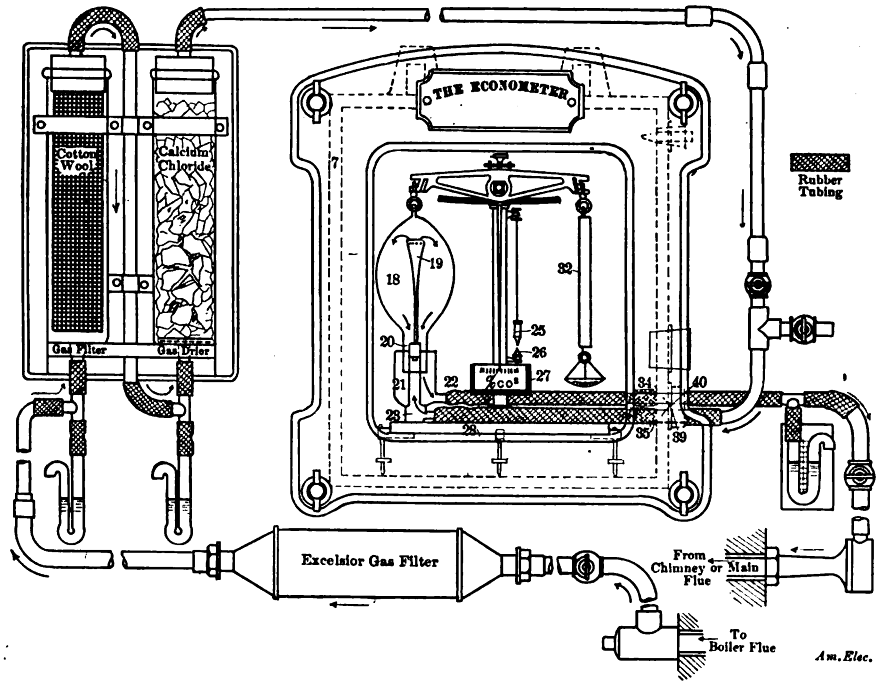


FIG. 2.—ARNDT'S ECONOMETER.

Absorption now begins. The gas is conveyed into the absorption tube, *c'*, by raising *B*, and at the same time opening *h'*. By causing the gas to travel back and forth from *c* to *A* the absorption is expedited. The reading is taken by raising *B* until its contents are on the same level with the water in the burette, *A*. The decrease in volume indicates directly the percentage by volume of carbon dioxide. In the same way oxygen is absorbed in *c''* and carbon monoxide in *c'''*. The residue which remains unabsorbed is principally nitrogen. Full directions for use of this instrument are given in a little book by Prof. A. H. Gill, entitled "Gas and Fuel Analysis for Engineers."

The engineer might find a gas composition A.

A.

CO_2	5.0
O	15.0
CO	0.0

which would show that combustion was complete, but that air was in very large excess, or he might get the composition B, showing both incomplete combustion and an excessive amount of air.

B.

CO_2	6.0
O	11.5
CO	1.5

With an obstruction of ash and clinker on the grate he might find composition C:

C.

CO_2	7.0
O	10.0
CO	2.0

Or he might find the very favorable condition:

D.

CO_2	14.0
O	5.0
CO	0.0

Just after coaling the fire the showing might be as below:

E.

CO_2	11.0
O	6.0
CO	2.0

After this fire had burned low and before replenishing the composition would often be represented by

F.

CO_2	2.0
O	17.0
CO	0.0

If the operator entered upon his work in earnest and made a study of conditions he would discover that with composition A the air supply was too large or that the coal supply was too small, generally the latter. The trouble with composition B would be that the condition of the fire was irregular; but by being leveled and made uniform, the gas composition would change and be similar to D. The condition C shows that the air supply through the fire is obstructed and not uniform and that the coal burning capacity is reduced, but that the air leakage into the furnace continues at the same rate, and is relatively larger in proportion, owing to less coal burning; it may be compared with D, showing much less air but complete combustion.

Condition E illustrates the effect of heaping in an excessive amount of coal at each coaling, and composition F shows what the result is when this burns down twenty or thirty minutes later.

An examination of these sample compositions will show that the carbon dioxide is influenced in amount by the conditions; in A it is low owing to too much air; in B, owing to both too much air and carbon monoxide, caused by irregular conditions; in C, by the fire being dirty; in E, by bad coaling and in F by a very low fire; while with D and the absence of the foregoing faults the carbon dioxide is high.

In view of the showing here given, it will appear that if there were any advantage in the method, the operator could pursue his studies by watching the conditions and knowing the amount of carbon dioxide only. This fact was taken advantage of by Arndt, a German inventor, who designed a continuous and automatic machine to indicate carbon dioxide in a moving sample of the gas, and which saves the labor, trouble and delay of the analysis. This instrument is shown in Fig. 2, and is known as Arndt's Econometer. It consists of a laboratory balance having a glass globe instead of the usual weighing pan, and being fixed in an air-tight case, 7, having a plate-glass front. A coupling, 40, is connected by a ⅜-in. pipe to the flue of the boiler about 2 ft. from the damper, and another connecting joint, 39, leads through a similar pipe to an aspirator in the main flue between the damper and the chimney, or the chimney itself. This constantly draws a sample of the gases from the boiler flue through filters, gas pipes and the balance, discharging it back into the chimney. In the interior of the case, 7, the joint, 40, is connected with the ascending pipe, 23, and the joint, 39, with the descending pipe, 22, by means of india rubber tubes, 34 and 35.

The gas-weighing machine itself consists of a very finely adjusted and highly sensitive balance to which is fixed a pointer. On one end of the balance is suspended an open glass globe, 18, having a capacity of about a pint, and on the opposite end a compensating rod, 32, to which is affixed a scale-pan with a number of glass beads and filings by means of which the gas-holder may be balanced. The knife edges of the balance are steel gilded, and the caps are of agate. The whole balance is mounted on a pillar screwed on a cast plate, 28. The latter has adjusting screws by means of which the balance is set both horizontally and vertically; in order to indicate the proper setting, a small pendulum is attached to the supporting pillar. A frame, 27, is fixed on the pillar, in which is inserted the scale card. The gas-ascending pipe, 23, reaches into the gas holder or weighing globe, 18, which has a neck, 20, open below and surrounded by a cup, 21, open above. The neck, 20, has free play around the glass tube, 19, as well as cup 21, so that the gas holder can swing free from resistance. The combustion gases having to pass through filters and drying chambers, enter the weighing globe thoroughly cleansed and dried. As carbon dioxide is about 50 per cent heavier than air and the other gases in the chimney, the weight of the gases which continually fill the weighing globe will be greater than that of air in proportion to the amount of carbon dioxide contained therein. The scale, 27, is so divided that the movement of the pointer from one division to another corresponds with the volumetric percentage of carbon dioxide in the gases to be weighed. The amount of carbon dioxide in the gases can therefore be read off directly at all times.

This instrument is usually mounted at a convenient point on the wall of the boiler room and pipes are extended from the different boilers to a header near the instrument and delivering to it; by cutting in or out a pipe by means of a stop cock any boiler may be tested, or by enclosing this header a test may be made of the work of any fireman without his knowing it.

About once a week the instrument should be tested for the zero point by drawing air through it by way of the cock on the tee attached to pipe 39, with the upper cock closed and the cock on pipe 40 open as in regular use. Adjustment for zero is made by removing a rubber plug in the side of the case and adding or removing iron filings in the scale pan by means of a magnetic needle. About once a month the filter should be withdrawn from its chamber and brushed off. From once to twice a month the calcium chloride which has been used should be replaced. Every day the gas pipes between the header and boilers should be blown out with air; where compressed air is available this is best done by means of a three-way cock between the air pipe and header, but if the air under pressure is not available a hand pump may be used.

Soon after the advent of the econometer the gas "Composimeter" was brought out; it also indicates carbon dioxide, but by chemical means. The principle involved is the reduction of the volume of gas by removing the CO_2 and the amount of this reduction is in proportion to the amount of CO_2; the reduced pressure consequent upon the reduced volume is communicated to a water column which rises or falls over a graduated scale. The usual arrangement is to provide a separate instrument for each boiler, and to locate them in a special room.

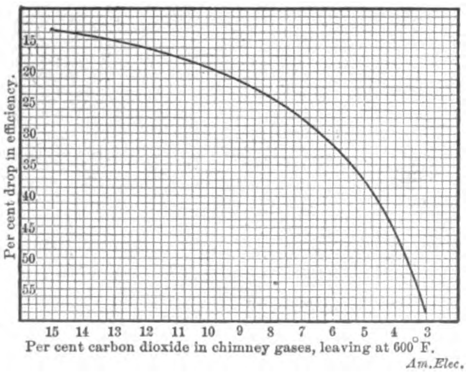


FIG. 3.—PERCENTAGE CURVE.

Should the engineer be ambitious to make examinations of gas mixtures for possible hydrocarbons, the best instrument would be Hempel's apparatus, which consists of an aggregation of measuring burettes and various pipettes; it is a laboratory apparatus, and is not readily portable. This instrument, however, would be of such slight practical value in electric station management as to exclude its consideration.

As to the extent of the use of the devices mentioned, it should be said that the Orsatt apparatus (Eimer & Amend, chemists, of New York,) is universally acknowledged the world over as the best for the purpose; all text books mention it, and it is extensively used in all countries except the United States, although quite a large number have been purchased here. The econometer is in use in fifteen or sixteen different countries, even in the Philippine and Sandwich Islands, India and China, but its use in the United States is rather limited as yet, only the better managed plants taking it up. The gas composimeter has had but a limited application; likewise Arndt's chemical CO_2 instrument.

These instruments may be mentioned in the order of their cost, beginning with the lowest priced, the Orsatt, Arndt's chemical CO_2 instrument, the econometer and the gas Composimeter. The CO_2 machines are not often mentioned in the text books, and where they are referred to, it is usually as novelties, or, possibly, as scientific toys. Later, when their value is better understood, they will be considered differently. The writer in his work uses two special forms of the Orsatt apparatus; a combination of the Orsatt and Hempel; the Hempel apparatus; the econometer and Arndt's CO_2 chemical instrument, but finds the econometer and chemical CO_2 instrument most useful as a guide in working fires for best efficiency.

The inquiry likely to be made by the station manager is, "What saving can be made?" This will depend on what his losses are now. It is a conservative estimate, however, to place the unnecessary losses at from 10 per cent to 20 per cent. If an Orsatt instrument is purchased and set on the shelf after the novelty of a few days' use has passed, or if an econometer is installed and likewise treated, the investment will be money wasted. But, on the other hand, if they are made proper use of, their value becomes very large. Unless a station, however, is a very small one, it will usually be desirable to place a competent man in direct charge to insure success.

As illustrating the loss owing to bad combustion, the accompanying diagram is of interest. It is based on complete combustion and shows the minimum loss with gases leaving at 600° F. for various reasonable ranges of CO_2.

There is a great opportunity for improvement, which will eventually be realized when the station manager gives the fuel matter and the boilers the same degree of intelligent consideration that he does the other engineering features. There is a great opportunity in electric lighting and railway work where loads change so much, to make most important gains in efficiency, and the writer will say that the average station manager will find in the fuel matter his best opportunity for saving, provided he goes about the matter in the right way, and he may be able to save the investment cost of new boilers in some cases.

In a station burning 50 tons of coal a day at $2 a ton, a saving of 15 per cent would obviously mean $15 a day, and it would pay to put on a special man who would be trained to his duties; even if he were paid $4 or $5 per day, it would be a profitable investment.

COAL HANDLING MACHINERY IN CENTRAL STATIONS.

BY F. L. HUTCHINSON.

In the early days of the electrical industry the coal burned under the boilers of central stations was handled almost entirely by manual labor. At that time the plants were all of small capacity compared with present-day practice, and coal handling, together with many other factors entering into the economical operation of such stations, did not receive the attention and systematic study that is now devoted to these subjects. The expense of handling coal and ashes in power stations was, some years ago, considered a minor one when compared with the

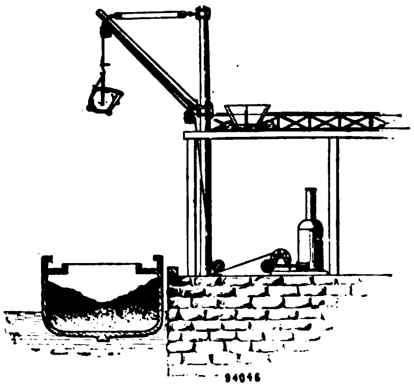


FIG. 1.

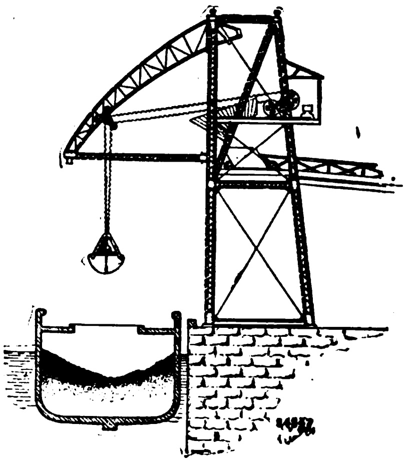


FIG. 2.—ELEVATOR ARRANGEMENT.

other expenses of the plant. The great reduction in the operating expenses of central stations that has been made of late years by the introduction of boilers of great capacity, automatic stokers and other improved devices, has reduced the labor cost of steam generation to such an extent that the expense of handling coal and ashes by hand labor becomes a more prominent factor, and justifies an outlay for installing labor-saving appliances that a few years ago would not have been seriously considered.

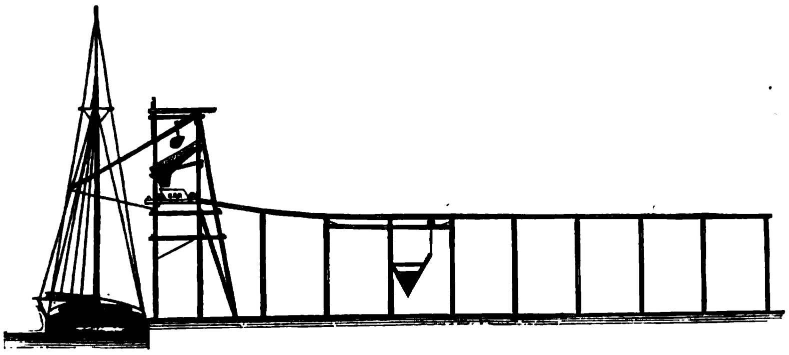


FIG. 3.—AUTOMATIC RAILWAY.

Power plants are not usually erected in ideal situations, but are located where property can be purchased or made available, and the coal handling machinery is frequently required to be complex and expensive, in order to meet peculiar and unfavorable conditions, and at the same time to obtain the greatest economy in the daily operation of the plant.

It is a well established practice in modern central stations to convey the coal to storage pockets and hoppers above the boilers, whence it is passed by gravity through automatic weighing apparatus to the automatic stokers, or, in case firing is done by hand, the coal can be chuted from the weighing apparatus to the floor in front of the boilers. In some cases no weighing apparatus is used and the coal is then drawn directly through chutes from the hoppers, but in nearly all the large and many of the smaller stations, it is now the practice to weigh the coal and to keep records of the amount used.

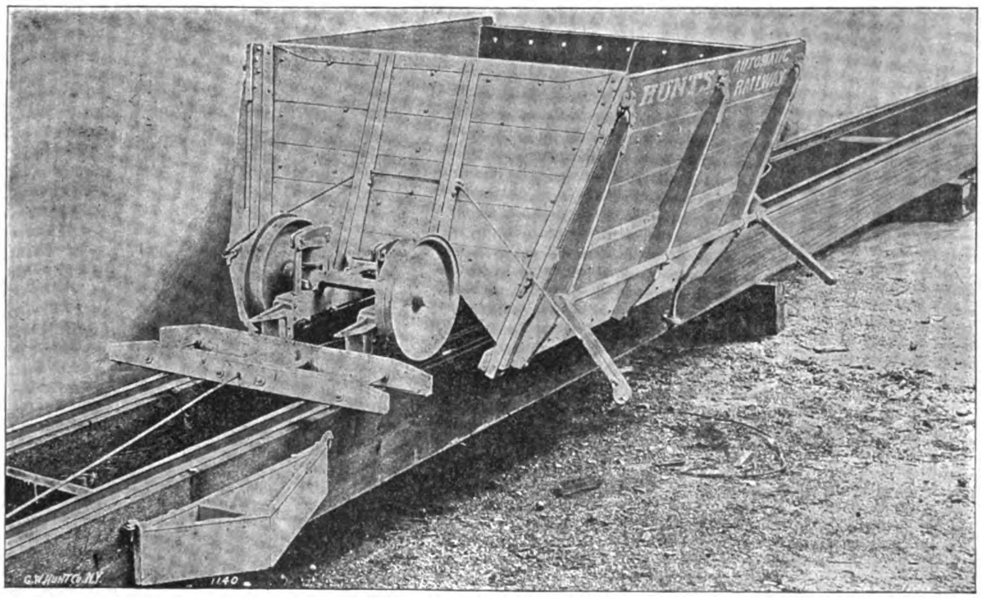


FIG. 4.—AUTOMATIC RAILWAY CAR.

From the above it is evident that the principal work to be performed by coal handling machinery is to raise the coal to the storage pockets above the boiler. The apparatus used for this purpose depends largely upon the manner in which coal is received at the station. Coal usually reaches a central station either in cars, or, in case the plant is located on a water front, by boat. In the latter case it is necessary to use machinery for taking the coal from the vessels and placing it in suitable storage pockets. Machinery for this purpose is different in mechanical construction from other coal handling apparatus.

Fig. 1 shows an arrangement that is very frequently used for unloading coal from boats. It is simply a combination of a mast and gaff with a coal bucket and a steam hoisting engine. The form of coal tub which is in most general use is top-heavy when full and bottom-heavy when empty, and consequently is self dumping and self righting. This arrangement is inexpensive but, of course, is not economical where a large amount of coal is to be handled and it is only applicable where the height to which the coal is to be raised is comparatively small. Fig. 2 shows an elevator arrangement by means of which the coal can be raised more rapidly and to a greater height. It consists of a steam shovel instead of a tub, and a steel tower instead of a mast and gaff. There are numerous forms of towers built, but the general principle is indicated by this engraving. When the tub or shovel reaches the top of the tower the coal is usually either dumped into chutes which lead to coal pockets, or it is dumped into cars and then transported to the pockets. In some cases it is dumped into a hopper and then taken directly to a storage pocket by a "conveyor."

Fig. 3 shows an arrangement which is very extensively used for transporting coal from a wharf to the coal pockets. It is an automatic railway operating entirely by gravity. The track is built upon a slight down grade from the wharf to the storage pocket. Only one man is needed to operate the railway; he loads and starts the car, which runs down the track, dumps its load at any desired point and returns to the workman. The principle consists in storing sufficient energy, acquired from the descent of the loaded car on the inclined track, to return the empty car to the starting point. When the loaded car reaches the storage pocket, it has raised

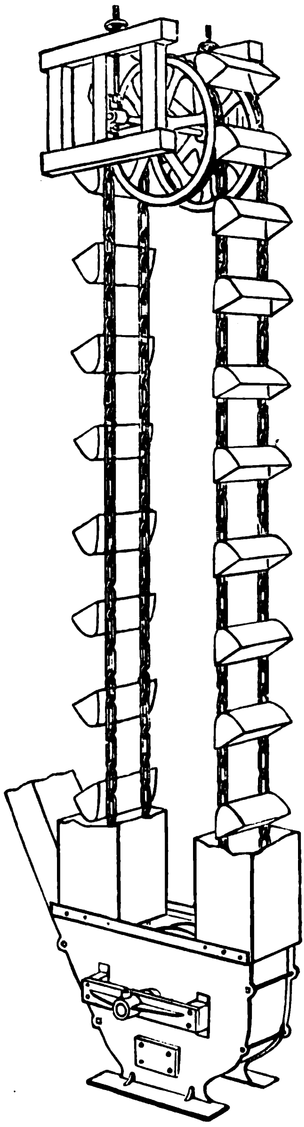


FIG 5.—HARRISON DOUBLE STRAND BUCKET ELEVATOR.

a counterweight to a certain height by means of a steel cable which the car takes up while running down the track. The weight is so arranged that it is raised only to a limited distance, its purpose being only to start the car back, the momentum carrying it the remaining distance. This railway is inexpensive both in first cost and in operation.

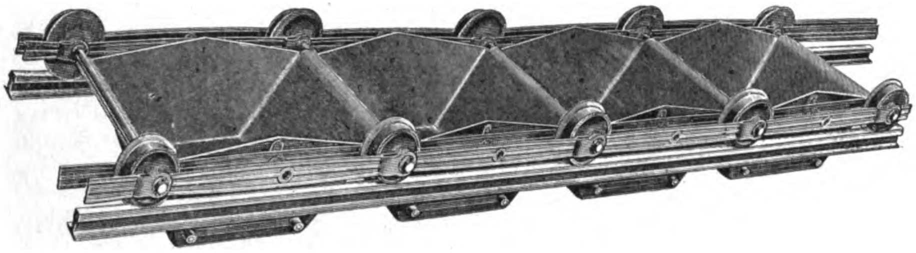


FIG. 6. SECTION OF M'CASLIN CONVEYOR, SHOWING OVERLAPPING BUCKETS.

Fig. 4 shows one of the standard cars built by the C. W. Hunt Company, New York, for use on an automatic railway. This car discharges its load by means of a tripping block placed on the track at the desired dumping point. This block causes the sides, which are hinged to the car and connected together, to open simultaneously, thereby enabling the load to be discharged evenly and without danger of overturning the car, although it runs on a narrow-gauge track. Of course the field of usefulness for the automatic railway is limited to a distance of say, 600 ft., and to cases where a straight track with a slight down grade from the wharf to the storage pocket can be used. In cases where cars must travel up inclines or around curves, or where the storage pocket is located at a comparatively great distance from the wharf, a cable railway may be used.

Cable railways are operated by a running wire rope to which the cars may be attached, either permanently or intermittently. The rope should move slowly, it being best to obtain capacity by increasing the number and size of the cars rather than by operating at high speed. Cable roads may be arranged for coal handling in one of the following three ways: First, the cable may run constantly, the cars being attached at any point and drawn around the track until the grip is released. Second, two cars may be used, running in opposite directions and passing each other on a switch or double track; this is called the double shuttle cable railway. Third, one car only may be used and drawn back and forth by the cable; this is called the single shuttle cable railway.

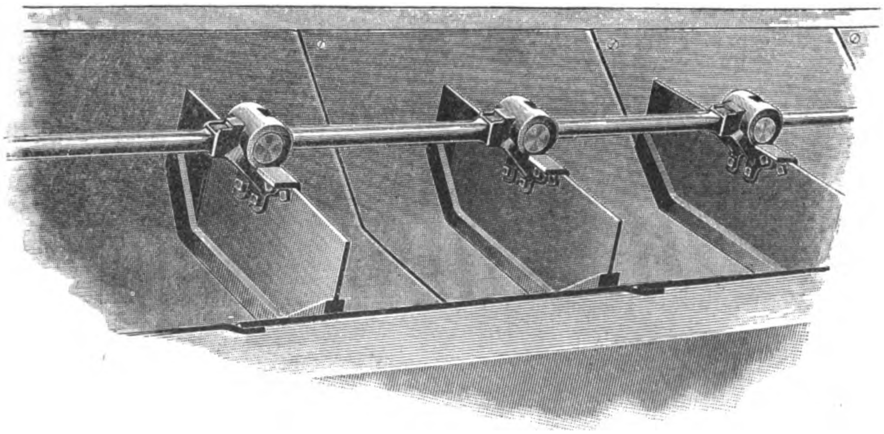


FIG. 8.—"MONOBAR" CONVEYOR.

It is not necessary for an attendant to accompany the car, as it will follow the track over the storage pocket and automatically dump its load at any desired point and return again to the wharf, where the workman may unfasten the grip and run the car under the loading hopper for reloading.

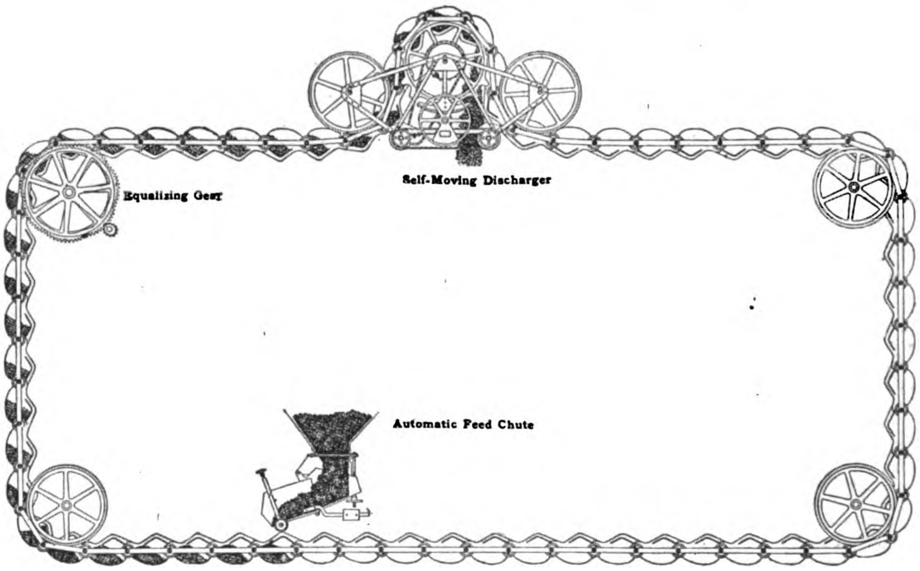


FIG. 7.—LINK BELT ENGINEERING COMPANY'S CONVEYOR.

In many cases where coal is received in cars, if sufficient room can be obtained an inclined trestle is built and the cars are run directly over the storage pocket, thereby allowing the load to be dumped without the assistance of any of the apparatus already mentioned. In many of the large stations the height to which the trestle would have to be built prevents its use, on account of the great area required and the expense of construction. For such stations, coal being received at the street level, it is necessary to elevate it to the coal pockets. The apparatus already described for unloading boats would not be applicable in this case. Fig. 5 shows an arrangement, which is frequently used when the coal pocket is immediately above the point of delivery to the station; it is a form of bucket elevator manufactured by the Borden & Selleck Company, of Chicago. Where the coal pocket is not directly over the delivery point, a conveyor system must be used.

In many large stations there is not enough room above the boilers for storage pockets of sufficient capacity to store as much coal as desired, and it is therefore customary to build storage pockets separate from the power station. In some cases no pockets are built above the boilers, the coal being conveyed directly from the large storage pocket to the hoppers. The tendency, however, is to store a large quantity above the boilers. Where pockets are located both above the boilers and also outside the power house, the arrangement is frequently such that the machinery can deliver the coal to either of the pockets. In any case, where there is a pocket separate from the power house, it is essential that labor-saving machinery be installed to carry the coal from this point to the bins or hoppers above the boilers. A conveyor system, which is usually the most important coal handling device in a central station, is employed for this work. One form of conveyor is illustrated in Fig. 6; it consists of overlapping buckets pivotally mounted on an endless chain of link bars and cross shafts, the latter carrying wheels on each side of the system, by means of which it follows a pair of track rails. This form is known as the McCaslin conveyor, and is manufactured by the John A. Mead Manufacturing Company, New York.

A conveyor manufactured by the Link Belt Engineering Company, Philadelphia, is shown in Fig. 7. The coal passes by gravity through the feed chute, shown in the lower part of the illustration, into the buckets and is then carried, as indicated, to the point where it is desired to dump the coal, where a self-moving discharger, shown in the upper part of the cut, is located. A very different form of conveyor, also manufactured by the Link Belt Engineering Company, is shown in Fig. 8. It is called the "Monobar" and, as the illustration indicates, consists of flights which are secured to the bar and which transport the coal by pushing it along a steel conveyor trough.

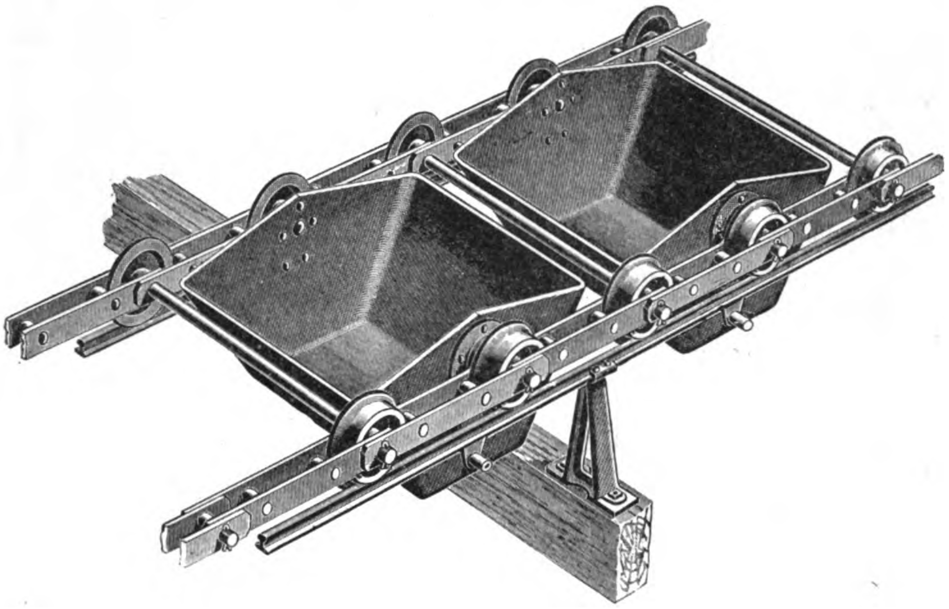


FIG. 9.—HUNT CONVEYOR, CHAIN AND BUCKETS.

A conveyor manufactured by the C. W. Hunt Company is illustrated in Fig. 9. This conveyor differs from the ordinary chain conveyors in many particulars. While it is usually called a conveyor and classed with this machinery, it is, in fact, a series of cars linked together, each having a body hung on pivots, gravity keeping them in an upright position, no matter whether the track is horizontal, vertical or inclined. The motion of the conveyor is obtained by pawls pushing the chain along as shown in Fig. 10. The pawl wheel is usually driven by a direct-connected two-cylinder engine or by an electric motor. The central cam is stationary and serves to keep the pawls out of contact with the pins on the chain, except when they are at the proper angle. The series of pans comprising the filler, shown in Fig. 11, are driven by means of the conveyor chain, and therefore these pans and the conveyor buckets move at the same rate of speed and each bucket is completely filled as it passes underneath the filler.

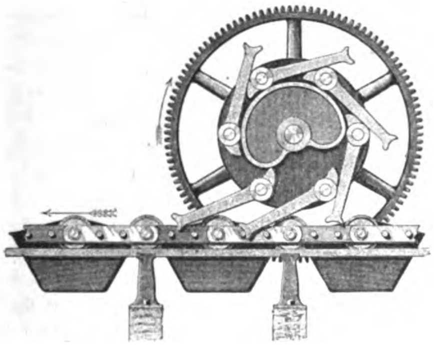


FIG. 10.—DRIVING MECHANISM OF HUNT GRAVITY CONVEYOR.

Another device, called a coal breaker, which it is frequently necessary to use in central stations for breaking the large lumps of bituminous coal into small pieces that will feed through automatic stokers used under the boilers, is shown in Fig. 12. The points on the rolls through which the coal passes should be designed to crack and not to literally crush the lumps of coal, so that none of the advantages of lump coal will be lost. The coal breaker may be so located in the station that the coal passes through it directly into the coal pocket. Machines of this type are built by nearly all makers of coal handling machinery.

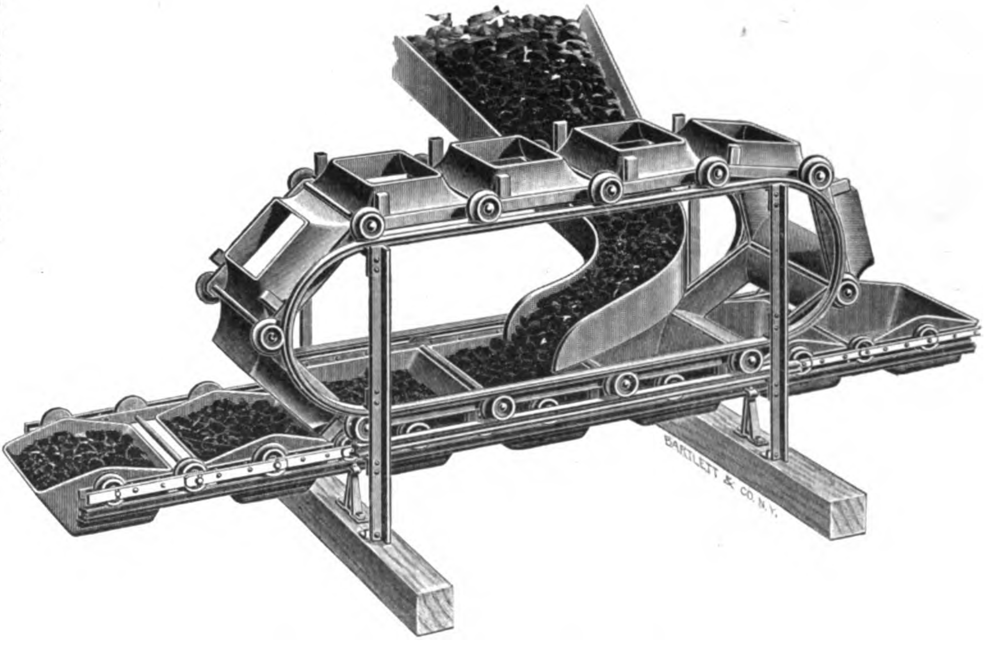


FIG. 11.—SPOUT FILLER FOR HUNT GRAVITY CONVEYOR.

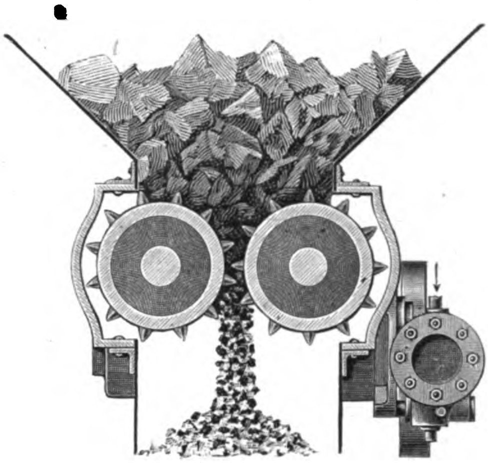


FIG. 12.—COAL BREAKER.

Fig. 13 shows a weighing hopper and patent balanced coal valve built by the C. W. Hunt Company. This is for use in boiler rooms where it is required to weigh the coal. This apparatus combined with a suspension scale is shown in Fig. 14. After being weighed the coal is spouted from the lower end of the hopper into the steam boiler stokers or any other receptacle. The entire outfit, including scales, hoppers and spout, is suspended from a trolley that runs along an overhead track; hence the scale and other apparatus can be moved from one boiler to another. Coal hoppers of this kind usually hold 500 to 1000 lbs. of coal.

The limits of this article prevent anything more than a brief mention of some of the more important coal-handling machinery that is commonly used in central stations. There are many other devices, and many other companies manufacturing coal-handling apparatus, that have not been mentioned, and some of the companies whose apparatus is illustrated herewith manufacture, in addition to the machinery mentioned, all apparatus necessary for complete coal-handling systems for the largest stations.

Stations of small capacity would, of

course, not be justified in making the expenditure required for an elaborate system. In such cases an experienced engineer must go over the ground and determine what will result in the greatest saving. While no definite rule can be given, it is generally true that unless the conditions for manual labor are particularly good, any plant of more than 500 horse-power capacity, and many smaller ones, can save money by installing a more or less complete coal-handling system.

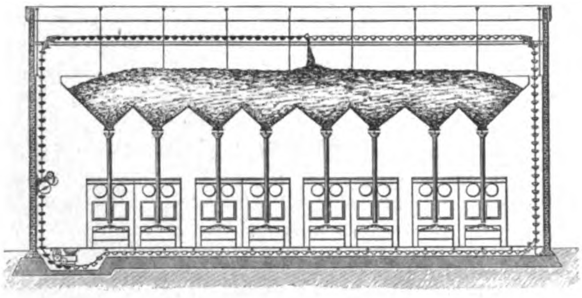


FIG. 15.—EDISON PLANT AT NEW ORLEANS.

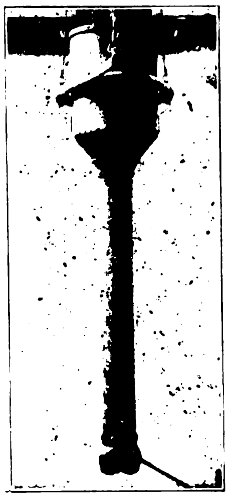


FIG. 13.

The accompanying outline drawings are inserted in order to indicate how the various devices described herein have been combined to form complete coal-handling systems. Fig. 15 represents a plant at which the coal is received in wagons and dumped into a hopper from which it passes through a coal breaker to the conveyor buckets, as indicated at the lower left-hand corner of the sketch. The conveyor carries the coal to the storage bin above the boilers. From here it is drawn to the automatic stokers through the suspended weighing hoppers. The same conveyor receives the ashes from the furnaces, carrying them to an elevated bin from which they can be spouted into carts. At the plant shown in Fig. 16 the coal is received in cars on wagons and dumped into the hopper shown in the lower left-hand corner. The conveyor then carries it to the storage bins over the boilers, whence it passes through weighing hoppers. The conveyor passes under the furnaces and collects the ashes, which are carried to a hopper from which they can be spouted into carts.

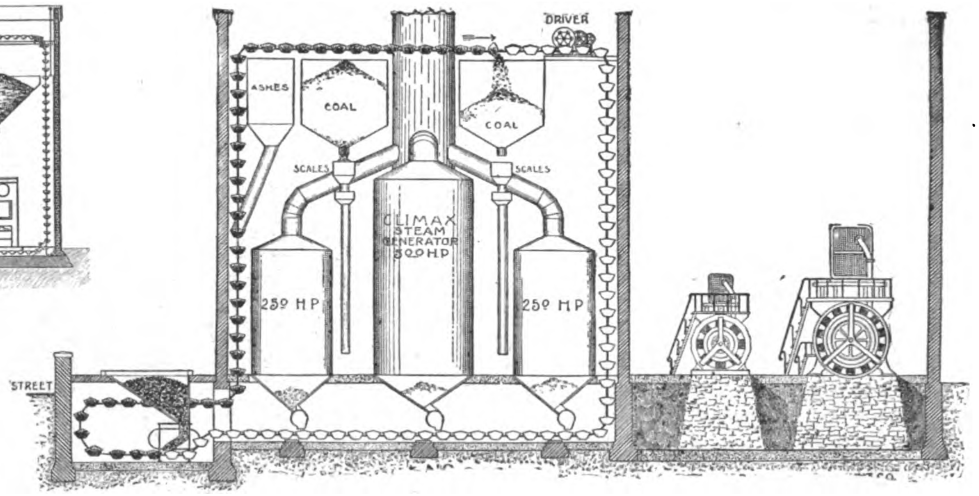


FIG. 16.—SECTIONAL VIEW OF ELECTRIC LIGHTING PLANT.

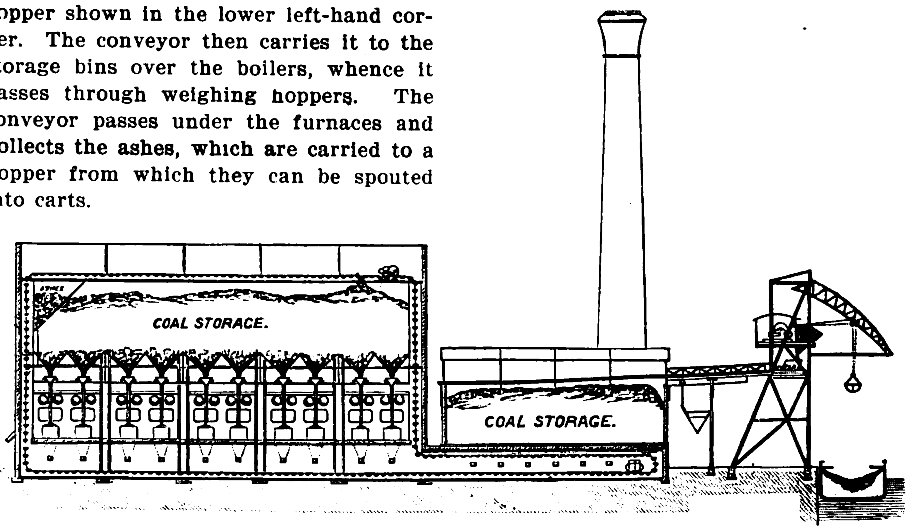


FIG. 18.—DUBLIN UNITED TRAMWAYS PLANT.

Fig. 17 shows the coal-handling arrangement at a large station on the water front. The coal is received by boat and unloaded by means of an elevator consisting of a parabolic boom tower and steam shovel. The coal is hoisted 125 ft., cracked to a size suitable for a boiler furnace stoker, weighed, run into an automatic railway car and carried directly to a storage pocket of large capacity, above the boilers, as indicated. The coal is then spouted by gravity to the stokers. A car is used for removing the ashes.

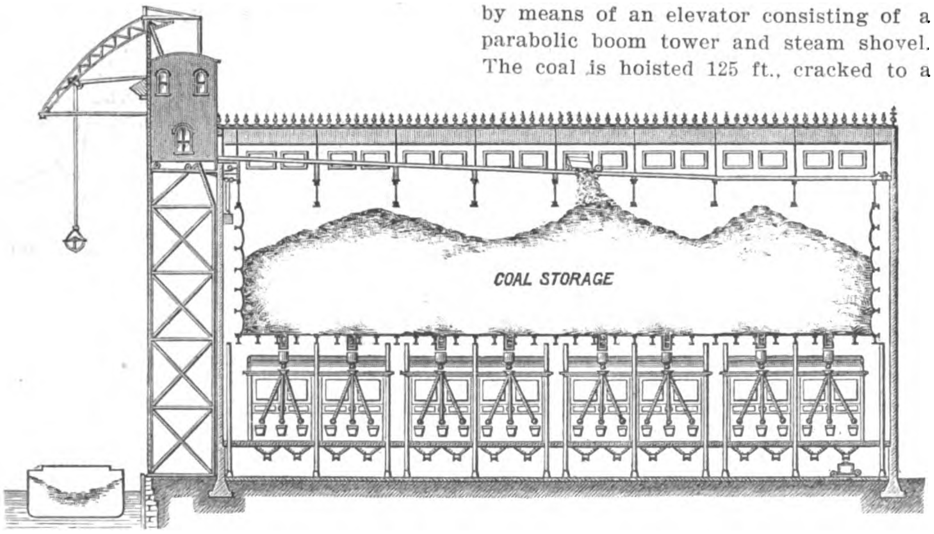


FIG. 17.—COAL HANDLING ARRANGEMENT FOR LARGE STATION ON WATER FRONT.

Fig. 18 is a sketch of the Dublin United Tramways plant. The coal is unloaded from boats and placed in storage by means of a Hunt elevator and automatic railway, the arrangement being similar to that shown in Fig. 17. The coal is then carried to the storage pocket above the boilers by a Hunt conveyor system, which also passes under the furnaces and carries the ashes to a pocket shown at the upper left-hand side, from which they can be re-

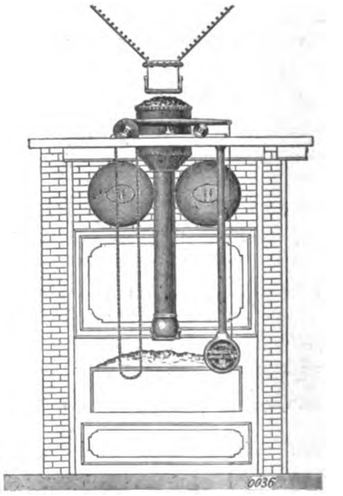


FIG. 14.

moved by carts at convenience. Each boiler has an independent weighing scale, the coal passing through hoppers and spouts to automatic stokers.

Of course it is seldom that the same identical arrangement prevails in two different plants, and therefore various modifications are made in order to suit local conditions. The particular machinery that should be installed in any given station in order to produce the most economical results can only be decided upon by taking into consideration all the conditions of that particular plant, such as the location, capacity, rate of wages, the amount of coal to be handled per year, the greatest amount to be handled per day, the regularity or irregularity in the receipt of coal, whether coal is received by boat or by car, etc., etc.

It is a popular idea that because coal is heavy and dusty, coal-handling machinery is crude and rough. This is a wholly mistaken belief. In order to do this work satisfactorily, apparatus for handling coal, like all other machinery, must be designed and built with particular reference to the conditions under which it is to be used. The very fact that coal must be handled under conditions that are more or less unfavorable makes it necessary that the working parts of steam shovels, elevators, automatic and cable railways, conveyor systems and other coal-handling devices, shall be thoroughly studied and carefully designed, and the materials entering into their construction shall be carefully selected and accurately worked into shape.

It may seem at first sight to be a useless refinement to work to templets, grind shafts on centers to vary less than one-thousandth of an inch, make taper fits, etc., on machinery that is to be roughly handled, covered with grease and dust, and exposed to storms, but experience shows that it is a positive economy. Durability and freedom from delays justify this care and expense.

Abstracts from Foreign Contemporaries

Coal Burning Internal-Combustion Engine. — We are indebted to the London "Mechanical Engineer" for the following description of a new two-cycle internal-combustion engine, said to use ordinary coal in a pulverized state. The engine was invented by P. F. MacCallum, and is on exhibition at the Glasgow Exhibition. It is of the vertical type, with a trunk piston enclosed in a cylinder, the upper part of which (the clearance or compression chamber) is termed the expansion cylinder and the lower part the working cylinder. No water jacket is employed on the main cylinder, but the working surfaces are protected and cooled by another method of interior water circulation. Alongside the "expansion cylinder," and communicating therewith by means of a port, is placed the combustion chamber. The fuel is forced into the combustion chamber at the required intervals by a timed jet of compressed air working in conjunction with a rotary charge plate and automatic check valve. The crank chamber of the engine is enclosed, and the main piston also acts as a pump for forcing air into the combustion chamber. Under normal conditions the engine gives a working impulse for every revolution, the working cycle being as follows: The upstroke of the piston compresses a charge of air in the combustion chamber, another charge of air being at the same time drawn into the crank chamber. When the piston reaches the top of the stroke, a charge of fuel is injected into the compressed air in the combustion chamber, combustion takes place, causing rise in pressure, and a working downstroke is made. The piston having terminated its downstroke, the exhaust valve opens, allowing the waste products to escape, and a fresh charge of air at the same time passes from the crank chamber to the upper part of the cylinder. This is again compressed by the upstroke of the piston into the combustion chamber, in readiness for another fuel injection, and so on. Unlike the ordinary gas engine, there is said to be a gradual increase in pressure, giving a more even turning moment and thus obviating shock. The engine exhibited develops 100 horse-power at a speed of 150 r.p.m. and is not expected to use more than half a pound of coal per horse-power hour.

Metallic Gland Packing.—The accompanying illustrations, taken from London "Engineering," show a form of metallic packing now in use in Great Britain. In Figs. 1 and 2 the piston rod is denoted by *A*, and the stuffing-box by *B*; *G* is a loosely fitting bushing which serves to keep the packing in place under the pressure of the spring, *H*. The packing is made in six pieces, lettered *E* and *F*, and shown separately in Fig. 4 and in their proper position in Fig. 3. After being thus put together, the spring shown by Fig. 5 is slipped over the whole, and serves to keep them together. As indicated in Fig. 3 the pieces rest on a beveled seat turned on the bushing, *G*, shown complete by Fig. 6. The cover, *G*, which closes the stuffing-box after the packing is in place, is finished true on its inner face, thus making a steam-tight joint with the opposing faces of the packing pieces. The packing can be used inside any ordinary stuffing-box without alteration, and once in place requires no readjustment.

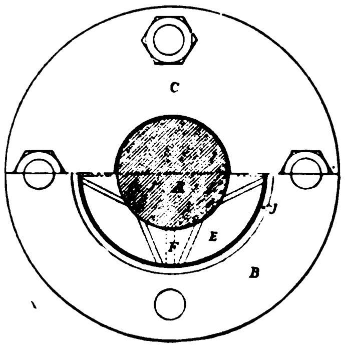


FIG. 1.—ARRANGEMENT OF PACKING.

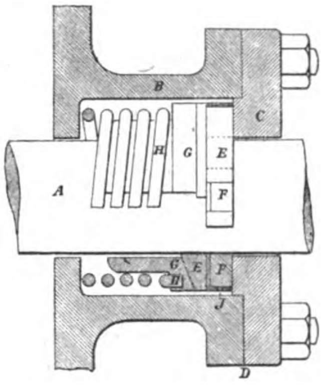


FIG. 2.—SECTION OF STUFFING BOX.

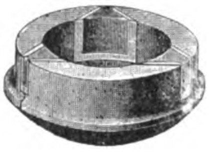


FIG. 3.

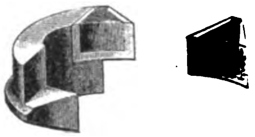


FIG. 4.

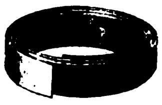


FIG. 5.

Steam Engine Cylinder Proportions.—In a paper recently read before the British Civil and Mechanical Engineers' Society, Mr. Alfred Hanssen discussed the question of cylinder proportions in multiple-expansion steam engines. An equal distribution of power between the several cylinders is of great importance in cases where each cylinder is connected to a separate crank, and where the load is constant. Tests of multiple expansion engines of good proportions, but which have not shown the steam economy which might have been expected, have revealed the fact that the presence of water in the cylinders was the principal cause of the large steam consumption. This presence of water may be due to a number of causes which may be easily remedied or in a measure mitigated. Professor Perry has shown that steam of 100 lbs. pressure per square inch condensed in the steam cylinder and drained off before it had time to re-evaporate, will impart 1054 thermal

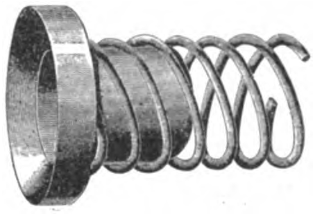


FIG 6.

units per pound of steam to the cylinder walls; but if this water is re-evaporated during the exhaust stroke at a temperature of 142° Fahr. only 60 units will be imparted to the cylinder walls. The maximum amount of work can be obtained with the least expenditure of heat, when dry steam is expanded without gaining or losing heat from the cylinder walls. The volume of steam in this cases increases, not as in isothermal expansion nearly inversely as the pressure, but inversely as the 0.88th power of the pressure. With engines having high piston speed, the adiabatic expansion curve is closely approximated in practice, and hence this may well be taken in determining the cylinder proportions. By constructing the curve for the pressure and total expansion ratio, and then dividing this diagram vertically into parts corresponding to the number of cylinders to be used, the cylinders being taken in geometrical progression, also dividing the diagram horizontally into a number of parts corresponding to the number of cylinders, each part representing the initial pressure in the corresponding cylinder, rectangles are obtained. These rectangles are of equal areas, and each contains an indicator diagram of nearly equal area, from which the cut-off, drop and other particulars can be easily measured, and the valve gear adjusted accordingly.

Continuous - Current Generator.—The London "Engineer," in a recent issue, describes a 500-kw. direct-current generator built by the Electric Construction Company, of Wolverhampton, and now on exhibition in Glasgow. It is over-compounded by 10 per cent, and, as shown by Fig. 7, has eight poles. A side view is given by Fig. 8, the upper half being in section. The fixed outside field yoke ring is 109 ins. outside diameter, and is split horizontally. It is of oval section, 32 ins. wide axially by 9 ins. radial depth at the center of its length, and is cast of high-permeability iron. The magnet cores are of soft iron plate "cast in" in the mold. The pole faces are made of soft iron forgings screwed on, and are shaped to give the proper gradation in magnetic intensity at the edges. The shunt winding is thickened from the ends toward the centers of the lengths of the cores in a pyramidal shape. The shunt and series windings are wound separately on formers and the series windings are placed next to the pole face, so that they can be removed without disturbing the shunt coils. The series windings are of rectangular section, that on each core being formed of two flat spirals connected without joint (?) at their inner turns, thus leaving both ends external for easy connection. The shunt current at normal load is 8.3 amperes, and the series winding takes up 1.2 kilowatts at full load. The armature is barrel-wound, with slotted core built up to 15 ins. axial length of charcoal iron stampings of 11 ins. radial depth. These are arranged in five groups, leaving four ample ventilating ducts between them. On the inner hollow of the cast-iron spider are cast oblique webs which act as fans and drive a vigorous cooling current through the armature. The armature core is bolted between two very stiff flanged end plates, the outer flanges being long enough (axially) to carry the projecting portions of the "barrel" winding. The external diameter of the armature is 62 ins. The inductor-bars are connected up in pairs, each pair forming a loop without joint, after the machine-formed pattern. The slots are straight-sided, their lining and the taping giving insulation which is tested at 300 volts alternating, each loop being tested independently. The insulation resistance is 10 megohms. Hardwood wedge strips and metal bands secure the inductors in the slots. The sectional area of each inductor is 0.0636 sq. ins. After running eight hours at full load the temperature, it is said, does not rise more than 50° Fahr.

The armature and commutator are mounted upon a heavy cast-iron spider, which, as shown by Fig. 8 expands at the driving end into a large stout flange. This is bolted to the face of the boss of the fly-wheel, and most of the driving torque is transmitted by it, the remainder being transmitted by the shaft. The commutator is 42 ins. in diameter by 11½ ins. face. It has 768 segments, or 96 per pole. The brush rods are held in a ring surrounding the inner end of the commutator. This ring rests, and is revolvable, in a circuit of rollers supported by brackets bolted on the end face of the yoke ring. The lead of the brushes is adjustable by the ordinary worm and hand-wheel arrangement; but they require no change of adjustment from light load to full load. The design of the machine conforms very closely, it is evident, to American practice.

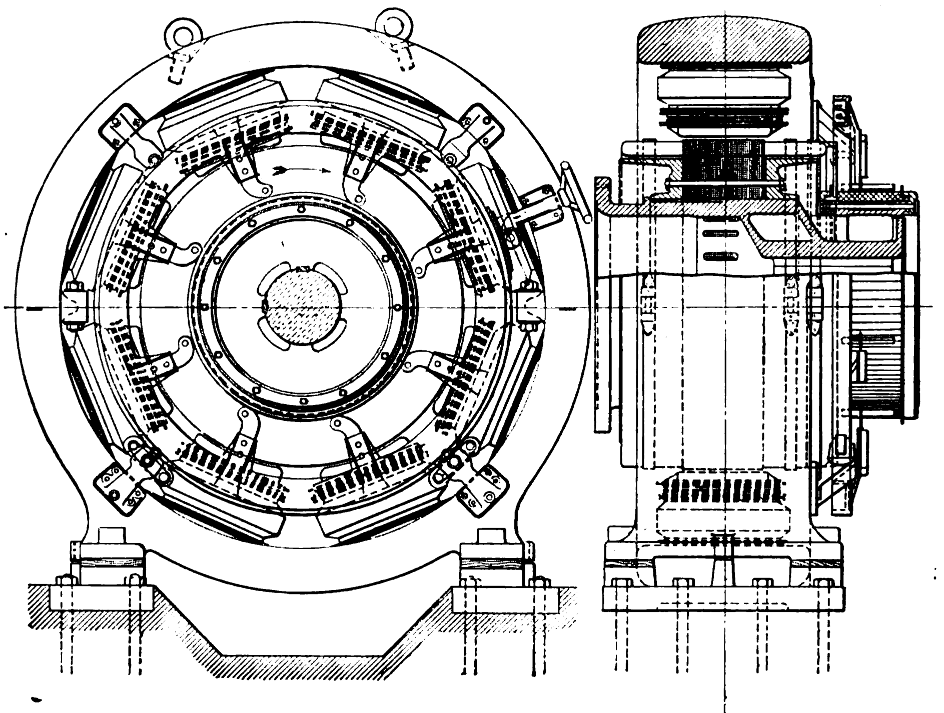


FIG. 7.—500 KW. DIRECT CURRENT GENERATOR--FIG. 8.

Improved Traction Cell.—An accumulator cell of light weight, small bulk, great mechanical strength, and capable of high rates of discharge, suitable for motor cars and similar class of work, has, according to the "Electro-chemist and Metallurgist and Metallurgical Review," been devised by J. T. Niblett, and will shortly be placed on the market. The cell deviates somewhat from ordinary lines, and as the result of some months' testing the following particulars are given out. The metallic conductor used is of small dimensions and little weight. It forms the backbone of the frame wherein the active material is contained, and is so arranged that all those parts immersed in the electrolyte and not covered by the active material are insulated. By this arrangement all of the lead salts are brought under direct electrolytic action, and therefore uniformity of formation is insured, both in the initial processes and also in the charging and discharging operations, and greater efficiency is obtained. The material employed in both the positive and negative plates is not the usual lead oxides; but is a compound of lead salts produced electrolytically, and is of a conductive nature. When set and properly seasoned the material is of stone-like character, while possessing, at the same time, the necessary porosity. The cell, it is said, may be formed very rapidly, and the amount of energy consumed is but one-half of that required by the ordinary grid or pasted type of cell. As stated, the active material is of an extremely hard nature, and as the expansion on the positive and contraction on the negative plates during formation is greatly reduced, the elements do not tend to buckle, or "shed" their active material, either during formation or in the subsequent charging and discharging processes. It has also been found that the charging operation can be performed with a lower electromotive force than that usually required; from 2.2 to 2.3 volts per cell being sufficient to effectually recharge. The following particulars of a cell constructed for motor-car work are given:

Number of positive plates—4.
Number of negative plates—5.
Gross weight of conductors in plates—3 lbs. 10 ozs.
Gross weight of positive active material—8 lbs.
Gross weight of negative active material—6 lbs. 7 ozs.
Gross weight of complete cell, including containing vessel and electrolyte—24 lbs. 9 ozs.
Normal discharge rate—16 amperes.
Current density of positive surface at normal discharge—1 ampere for 7 sq. ins.
Capacity—160 ampere-hours.
Capacity per pound of complete cell—6.55 ampere-hours.

The above results are obtained with a fall of potential to 1.75 volts per cell; but under ordinary conditions the e.m.f. may be safely run down to 1.7 volts without injury to the elements or loss in efficiency. At half rates of discharge the capacity per pound of cell was found to be 7.6 ampere-hours.

Cable Connectors and Fuses.—The accompanying illustrations, taken from a recent issue of the London "Electrical Engineer," show the arrangement of cable connectors and fuses now in general use on the Glasgow Corporation mains. Fig. 9 shows two double-pole fuses and connectors, while details of the apparatus are shown by Fig. 10. It will be seen that standard practice at Glasgow provides double insulation between the fuses and the ironwork supporting them. The feature of the arrangement is the device by which the end of the cable is connected to the porcelain base of the fuse block. From Fig. 10 it may be seen that the end of the cable is connected into the one jaw of the fuse block, and also that the shank of this jaw is not passed through a hole in the porcelain block, but is slipped into position through a slot at the end of the porcelain. At the back surface a rubber ring is inserted and the jaw is locked by means of an eccentric locking lever. The fuses can be disconnected and removed, and the cables displaced without the use of a tool. At the end of the locking lever which secures the fuse jaw in position is a small circular hole. This is provided to test the circuit after the fuse has blown to see if the cause still exists, the other end of the cable making a momentary contact with the locking lever at the other end of the fuse block. From the flash which results an experienced man can tell whether the fuse has been blown on account of a short-circuit on the mains or on account of an overload. The damage done by this testing of the fuse gear is said to be negligible, and the danger arising from inserting a fuse while a short-circuit exists is avoided.

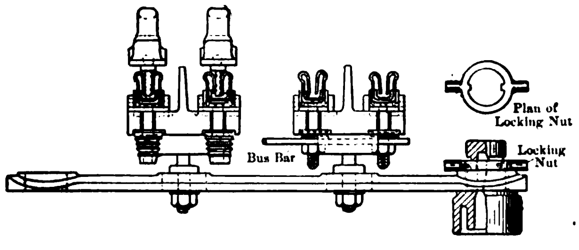


FIG. 9.—DOUBLE POLE FUSES.

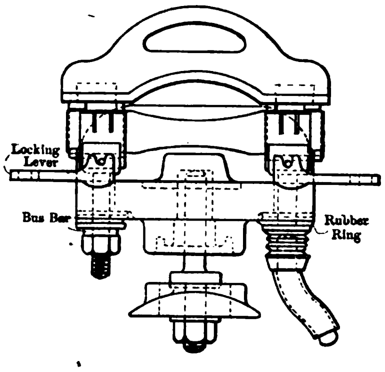


FIG. 10.—DOUBLE POLE FUSE.

New Electric Furnace.—The London "Electrical Review" describes an electric furnace designed by A. Parker, which is said to possess none of the drawbacks of the present electric furnace and is therefore expected to give a much higher efficiency. The furnace consists essentially of a circular revolving crucible lined with carbon, and an elongated carbon as the positive electrode. Fig. 12 shows the relative proportion of the two. The crucible is fed by means of two hoppers fixed at either side of the positive electrode, and the feed is automatically arranged so that when the crucible revolves the powdered mass is conveyed in thin layers under the action of the electrode and is at once reduced to a molten condition. It is evident, as the crucible revolves and the hoppers are stationary, that the powdered mass is spread evenly over the bottom of the crucible; and the carbon also being stationary, each layer of the coke and lime receives the full effect of the current. As shown in the diagram, the corners of the electrode are within a comparatively short distance from the crucible sides, so that there will be no appreciable portion of the mass which is not thoroughly melted. The author claims that this is a great advance upon the older methods, where the electrodes are often buried in the mass of the material to be melted, or else rigidly fixed as regards the crucible, so that one part receives a large excess of the available heat and the crust receives less than its due share. In the course of the experiments performed with this furnace, it was found that the crucible filled faster than the electrode burnt away, and a device was used which automatically raised the electrode during the time that the furnace was working, so that the length of the arc was kept constant.

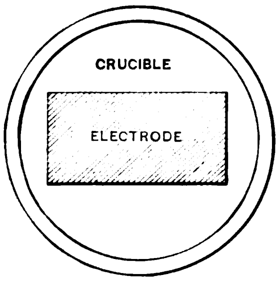
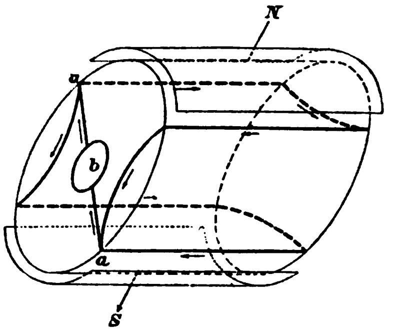


FIG. 12.

Deri Alternating-Current Motor.—Polyphase motors in their simplest form, with squirrel-cage rotors, have the defect of low starting torque. This may be increased, of course, by introducing resistance into the rotor "winding," but at the expense of efficiency. On the other hand, if the rotor has an external resistance which can be cut out at normal speed, the motor loses its great advantage of simplicity. Induction motors fed with single-phase currents are worse off in having no starting torque. This must be provided either by out-of-phase field windings to give a rotary field, or by giving the rotor a commutator by which its field can be displaced relatively to the inducing field. Herr Max Deri, of Vienna, has, according to the London "Engineer," devised a motor with a very ingenious form of rotor winding, in which resistance is put in or cut out by a change in the stator connections only. Considering first the winding for polyphase motors, a single turn is shown in the diagram, Fig. 11, short-circuited on itself and with an end connection, *a a*. In a two-pole field, as shown, the e.m.fs. induced in the two loops of the short-circuited winding are in opposition, and current must pass through the end connection, *a*, *b*, *a*. In a four-pole field, however, as shown by Fig 13, the points *a* and *a* are at the same potential and current passes around the short-circuited turn, and not through the end connection. Herr Deri then winds the rotor with short-circuited turns of low resistance, having the end connections, *a*, *b*, *a*,



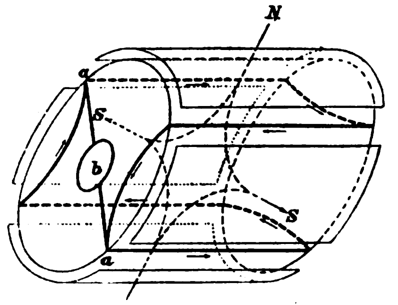


FIG. 11.—DERI ALTERNATING-CURRENT MOTOR.—FIG. 13.

of comparatively high resistance. To start a motor of, say, *n* poles, the field connections are changed to give ½*n* poles, so that the effective rotor windings include the resistance between *a* and *a*. On reaching the normal speed the field is changed to give *n* poles, and the end connections play no part in the rotor winding.

The same principle is applied to single-phase motors in conjunction with a commutator, of as many bars as there are complete turns. In a motor built for exhibition the field windings could be changed to give either six or eight poles in the following manner: In a six-pole field the two loops of each complete turn are electrically in parallel and connected to the commutator as in a direct-current armature. Each pair of brushes is short-circuited and placed in a line, making an angle with the inducing field, while the rotor current passes through the high-resistance end connections; on changing to an eight-pole field, the two loops of each turn are in series and short-circuited on themselves, so that the end connections and commutator are without current, and the motor runs as an ordinary induction motor with squirrel-cage rotor. The commutator, therefore, so especially objectionable with alternate currents, is in action only while the motor is getting up speed. The field connections are changed over at the right speed by a centrifugal governor fixed on one end of the shaft, and the motor is reversed either by reversing the field or by moving the brushes. A 6-h.p. motor under examination demonstrated the value of the arrangement, it is said, by giving 2.6 times its normal torque at starting with only 30 per cent extra current.

For small motors all change in the field connections can be avoided by winding it for six and eight poles, and connecting the two windings permanently in series. The windings are so designed that at starting the six-pole winding takes the greatest proportion of the current, while when the motor is running nearly synchronously, the eight-pole winding takes the greater part. The commutator is, of course, always carrying a certain current, but at normal speed it is small.

Some Recent Electrical Patents

Three-Wire Distribution.—One of the most flexible methods of supplying a three-wire system is to operate one or more full-potential generators connected to the outside leads of the system, and one or more half-potential generators connected between the neutral wire and each of the outer wires. One drawback inherent in such an arrangement is that when compound-wound machines are used, wide variations in load or any unbalancing of the system interferes seriously with the proper distribution of the load between the various dynamos. For this reason, when this method of supply is employed, it is customary to use plain shunt-wound machines, necessitating more attention, of course, on the part of the switchboard attendant. In order to obviate this difficulty, H. E. Heath has devised the system indicated diagrammatically by Fig. 1, for which a patent has been granted. Mr. Heath's method consists in using compound-wound dynamos of the ordinary type between the neutral and each of the outer wires, and a compound-wound dynamo with its series winding divided into two equal sections, connected to the extreme outer wires of the system. The full-potential dynamo has half of its series winding between one brush and the main circuit, and the other half between the other brush and the main circuit, and two equalizing wires, 11 and 14, connect the brushes of this machine to one brush of each of the half-potential machines. The result of this obviously is to put half the series winding of the large machine in parallel with the whole series winding of one of the smaller machines, and the other half in parallel with the whole series winding of the other smaller machine. It is obvious that any increase or decrease in the balanced load will affect all of the machines proportionally, and any increase or decrease of the load in one of the outer wires will affect the small dynamo on that side of the system and have a half effect on the full-potential machine. Patent No. 678,998.

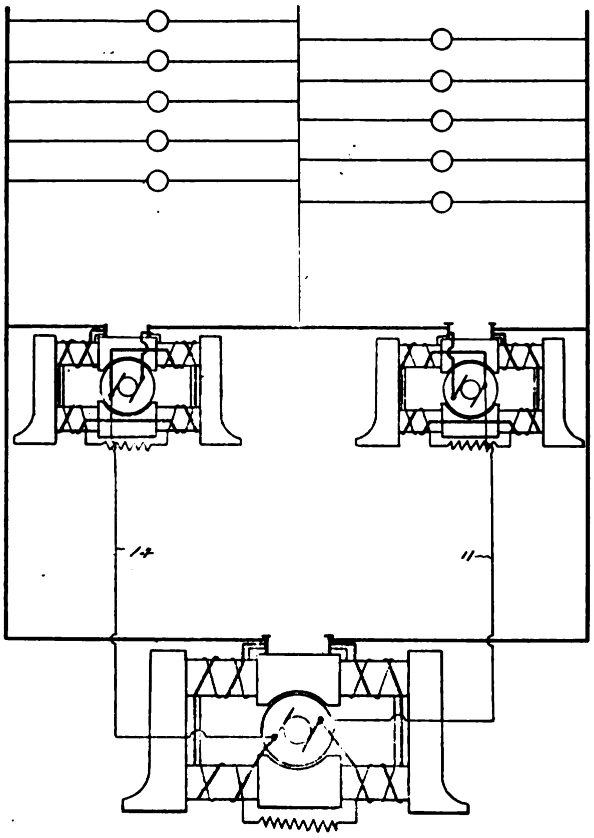


FIG. 1.—THREE-WIRE DISTRIBUTION.

Interior Wiring—Fig. 2, herewith, illustrates a form of interior conduit wiring for which a patent has been issued to Frederick Bathhurst, of England, and which consists broadly of a single bare conductor of an ordinary type threaded within an interiorly-insulated metal conduit, the metal portion of which constitutes the other conductor of the circuit. Mr. Bathhurst prefers to use the bare conductor within the tube for the positive side of the circuit, and the metallic conduit tube for the negative side, the tube being grounded, of course, so that no difference of potential can exist between the conduit and persons or objects in contact with the ground. Patent No. 680.834.

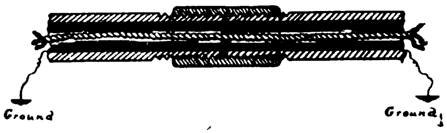


FIG. 2.—INTERIOR WIRING SYSTEM.

Single-break Knife Switch—A disadvantage common to the ordinary form of single-break knife switch is the difficulty of maintaining adequate contact between the knife blade and the post to which it is pivoted, the pivot and rubbing surfaces eventually wearing away until the hinge is loose and the resistance of the contact is increased. Another disadvantage which is incident to knife switches of all kinds is the burning of the contact jaws and the knife blades, due to arcing when the switch is opened. A type of switch designed to obviate both of these troubles

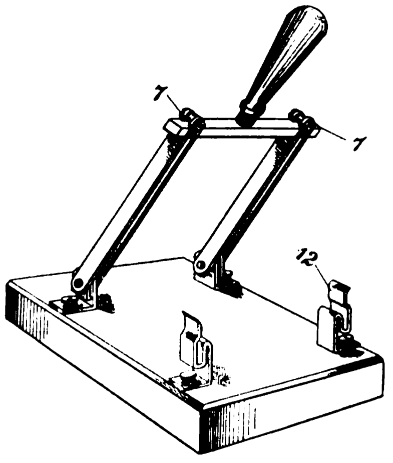
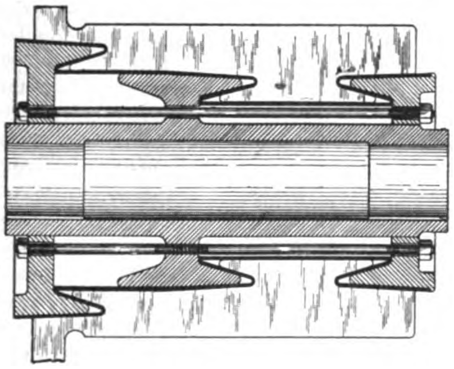


FIG. 3.—KNIFE SWITCH.

has been patented by Montgomery H. Johnson, and is illustrated by Fig. 3, herewith. The clip to which the blades are pivoted is made of sheet brass bent over into ∩-shape and given such a degree of spread that the spring of the metal will maintain it in good contact with the knife blade, the latter being made duplex and straddling the clip instead of being straddled by it, as in the more common forms. The contact clips are similarly bent over and straddled by the duplicate knife blades and they are also provided with an extension lug, 12, which first comes into contact with the blades on closing the switch, and at which the circuit is finally broken on opening it. The arcing, therefore, is restricted to these extension strips and to the other surfaces of the blades and the ∩-portions of the clips. The blades are each made of a single piece of strap copper bent into a loop and having a rectangular piece stamped out of the center of the strip where the bend occurs, so that when the strip is bent into shape two loops will be formed at the front end, as indicated at the point 7 in the engraving. The ends of the cross-bar are rabbeted, the neck between the two rabbets fitting between the loops of the knife blade; each end of the cross-bar is held in place by a bolt and nut, as shown. Patent No. 680,981.

Commutator Clamps.—When the ratio between the depth of a commutator segment and its length parallel with the shaft exceeds a certain value there is liability to the buckling of the commutator segment when the clamping nut at the end is set up. There is also liability to distortion of the segment at its center by centrifugal force if the commutator is a large one and has a very high peripheral speed. This difficulty is met by Henry Geisenhoner in the manner indicated by Fig. 4. Mr. Geisenhoner uses an intermediate support for the commutator segment which renders it impossible for the segment to buckle or be distorted. In order to provide for exactness in adjustment, the bolts which draw the clamping rings toward each other are divided into two sets, one set of which draws the central ring and the left-hand end ring together, and the other set draws the extreme outer rings together. Patent No. 678,171.



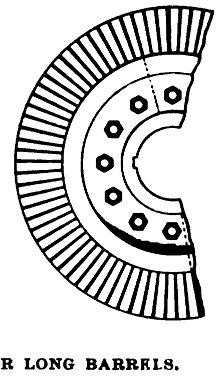


FIG. 4.—COMMUTATOR CLAMPING RINGS FOR LONG BARRELS.

HINTS ON LAYING OUT A STATION.

Valuable suggestions concerning the laying out of central stations of considerable output were given by Mr. E. W. Rice, Jr., in the course of his paper read at the recent annual meeting of the American Institute of Electrical Engineers. The boiler house, he said, should be sub-divided into two or more distinct sections, separated from each other by brick partitions, so that injury to one section will not involve the entire steam system. The steam piping should be in duplicate, or have a substantially equivalent arrangement; it should be so arranged that the bursting of a steam main cannot flood all of the sections of the boiler house with steam nor stop the entire supply to the engines.

The engines, with the dynamos, may be placed in one large room, provided this room is of sufficient size to enable the units to be placed at proper distances apart. The switchboard should preferably be placed in a separate room, so that any accident to the engine or to the steam piping cannot injure the switchboard operator or the switchboard mechanism. The electrical conductors from each dynamo should be led to the switchboard as far apart as possible from those of other units; each set of conductors should be led to its own switch. Each switch should be of ample capacity to interrupt the entire output of the generator at full voltage and even take care of the concentration of the entire load of the station, as in the case of a short-circuit. This switch should be placed in a cell of fireproof material and preferably electrically controlled from a central point. If thus disposed, these switches may be placed reasonably close together, but the partitions should be such that any one of the switches could arc to destruction without involving the switch of a neighboring generator. Switches should be in duplicate, so that in case of failure of one, another switch will be in readiness. Especial care should be taken, in leading the conductors from the switches to the bus-bar, to keep the conductors of each unit as far as possible from those of neighboring units.

The bus-bars should preferably be in duplicate, or some equivalent arrangement, such as sectional subdivision, should be adopted. Bus-bars should be carefully protected in fireproof compartments, so arranged that it would be impossible for any arc to short-circuit from one conductor to another, or for it to be injured by an arc caused by the destruction of any of the generator or feeder switches. The same care should be taken to isolate the conductors leading from the bus-bars to the feeder switches. The feeder switches should also be in duplicate; that is, two separate sets of switches on each feeder in series with each other when feasible, or the conductors leading to a group of feeders may be joined together by a switch placed in series therewith controlling a group of feeders. Each group switch and each of the feeder switches should be mounted in its own separate fireproof compartment and preferably controlled electrically from a distance. The conductors leading from the feeders out of the station should not be massed together in one conducting trench or well, but should be subdivided into as many groups as circumstances will permit.

The constant aim throughout the entire station should be to limit the normal flow of energy in a given space to a predetermined amount, preferably, for example, to that of the generator unit which has been selected; on in the case of the feeders leading outside the station the normal flow of a group may be limited to that delivered to any one sub-station.

It is obvious that the arrangement of switchboard, as described, will occupy more space than the ordinary panel type. The total space occupied, however, is but a small portion of the total space required for the generating plant, and it is believed that the precautions recommended are essential to the continued success and reliability of large generating plants. Such separation of the switches, etc., makes some method of control from a distance very desirable. The motors used for operating the switches may be either pneumatic or electric. The control of these motors should preferably be electric in all cases. By adopting electric control from a distance it is possible to combine all the switches required for the generator, feeders, etc., upon a small keyboard under the observation and control of a single operator. It is also possible to place this operator in such a position that he will have a comprehensive survey of all the measuring and controlling devices needed for the station, and at the same time be free from danger in case any of the apparatus should fail to perform its work. Under such circumstances the operator is much less liable to make a mistake, and it is believed that having taken such precautions accidents even of a trivial character will be more unlikely to occur. In laying out the electrical devices for such a station the utmost simplicity should be aimed at; not a single instrument, conductor or switch being placed in the station that has not been carefully considered and felt to be essential. It is better to err on the side of simplicity than that of complexity.

Effect of Scale in Boilers.—W. H. Bryan writing in an English paper on the subject of boiler scale, gives the following conclusions: (1) Ordinary boiler scale, which is usually more or less porous, has little or no effect on either the capacity or efficiency of the boiler until the deposits become so great as to impede circulation; (2) that the hard and dense scale sometimes met with will reduce both efficiency and capacity, but to an indeterminate extent, depending upon the quality and thickness. Under no circumstances, however, will the losses be anything like those given in the tables frequently published; (3) that the presence of even a small quantity of soot on the fire side of heating surfaces has an immediate detrimental effect on both capacity and efficiency.

Prof. Pupin's Discovery.

To the Editor, American Electrician;

Sir:—In a paper read by Prof. Pupin on March 28, before the Society of Arts of the Institute of Technology, and printed in the "Electrical World and Engineer" of July 20, a number of absurdities appear which show that Prof. Pupin's understanding of his discovery is not clear. The professor gives us to understand that it is the resistance of a telephone circuit which limits electric wave-transmission, because it is a dissipative factor, and that inductance and capacity do not limit wave-transmission because they are non-dissipative factors; and also that by sufficiently increasing the non-dissipative factors the dissipative factor can be relatively reduced to *any extent*, notwithstanding that the same amount of current will pass against *additional* line resistance. Professor Pupin evidently seems to think if a telephonic current were made to encounter sufficient non-dissipative reactions that it would pass over the line without being affected by the dissipative factor of the line at all; or, in other words, that the current would evade the resistance of the line.

In demonstrating by analogy, the professor says: "A light cord lying on an inclined rough surface may be set into periodic vibrations at one end by suitable mechanism. Owing to friction, wave energy on the cord is propagated only a short distance." Now, the deduction here is not even true of the analogy, for it is clearly evident if vibrations are imparted to one end of a cord, and those vibrations do not extend to the other end of the cord, that the cord must necessarily be flexible. Therefore, it would be the non-dissipate factor, or flexibility, of the cord (akin to capacity) which would make the marked attenuation, and not the dissipative factor, or friction, of the cord upon the rough surface (akin to electrical resistance) which the professor would have us believe. The further deduction made by the professor regarding a cord provided with "sinkers" acting to reduce the dissipation of energy, is extremely erroneous.

Prof. Pupin's discovery in telephony can be understood from the following: The resistance of a telephone circuit is a dissipative factor, and acts to reduce the volume of current, but the character of the wave-transmission of current is preserved, and the distance to which intelligible speech could be transmitted if resistance were the only impedance in the circuit would be greater than that made possible by Prof. Pupin's discovery.

The static capacity of a telephone circuit, although a non-dissipative factor, is most destructive to the transmission of intelligible speech over long extended telephone lines, since the circuit acts as a condenser to absorb the current. This would not be so serious if only a reduction in volume of current resulted, but the character of the undulations of current corresponding to voice sounds is greatly affected. First, for the reason that capacity in a circuit acts to absorb the higher frequencies of current much more than it does the lower ones; and second, for the reason that it acts to change the phase relations of the higher and lower frequencies, so that the higher frequencies of the overtones will not be in proper relation to the lower frequencies of the fundamentals, thus limiting the distance to which intelligible speech can be transmitted.

The inductance of a telephone line, like the capacity, affects the higher frequencies of current much more than the lower ones, and acts to distort the phase relation of the higher and lower frequencies; but unlike capacity, it lags the current in phase relation to the impressed e.m.f., whereas capacity advances the current in phase relation to the impressed e.m.f. Therefore, it can be readily understood that by balancing the inductance and capacity of a telephone circuit, the distortive action of capacity will be counteracted by the distortive action of inductance.

The capacity of the usual telephone line is large compared to its inductance, so that to effect a balance of inductance and capacity it is necessary to increase the inductance. Prof. Pupin found by experiment that the adding of inductance to a telephone line by placing certain sized inductance coils along the line at certain distances apart, gave a markedly improved telephonic result, and the professor is entitled to all the credit due him for his discovery, but he detracts from his work by stating that his discovery makes it possible to *reduce* the dissipation of electrical energy to *any extent*, whereas his discovery makes it possible to greatly *increase* the dissipation of electrical energy and still maintain good telephonic results.

Professor Pupin does not seem to understand at all that the improved result obtained by adding inductance to the circuit is due to inductance counteracting capacity, but seems to think that inductance counteracts resistance. For he says: "By a proper distribution of inductance coils at periodically recurring points, say one-eighth of a mile apart, the *inductance* reaction can be made very much larger than the *resistance* reaction for all frequencies which are of importance in telephony, and thus the dissipation diminished to any desired extent."

The placing of inductance coils along the line by the professor is to be highly appreciated, for the reason that distributed capacity is thus counteracted by distributed inductance, an accomplishment of great importance; but this is not appreciated by the professor, for he seems to think that the distribution of the inductance coils is necessary because of the length of the electrical waves to be transmitted, which is absurd.

Daniel Higham.

Winthrop, Mass.

NEW BOOKS.

The "Engineering" and Electric Traction Pocket Book. (Second Edition.) By Philip Dawson. New York: John Wiley & Sons; 1901. Soft leather; 1035 + xlvii. pages, 4 ins. x 6¾ ins.; illustrated. Price, $4.00.

This edition of Mr. Dawson's book contains considerably more material than the first one, as might have been expected. A section on gas engines and producer gas plants has been inserted, the appendix on power transmission has been enlarged by material on the electrical operation of factories, and a second appendix, devoted to English-metric conversion tables, has been added. The book contains a great deal of valuable material compiled from many sources; probably the most useful portion, from a practical engineering standpoint, is the section on Efficiency, Maintenance and Depreciation. This section presents the results of a large number of tests made on individual cars and complete railway plants. It is to be regretted that by far the most part of the contents consists of descriptive and dimensional data, such as are afforded by the manufacturer's catalogue, which every practising and operating engineer would naturally keep on file.

Annual Report of the Board of Regents of the Smithsonian Institution, Showing the Operations, Expenditures and Condition of the Institution for the Year Ending June 30, 1899. Washington: Government Printing Office, 1901. 715 pages, 7½ x 11 ins.

Only 87 pages of this large volume are devoted to a report proper; this amount of space is devoted to the secretary's report. Forty-three pages, numbered in Roman numerals, are for the most part devoted to the Proceedings of the Board of Regents, Report of the Executive Committee and Acts and Resolutions of Congress. All the rest of the book is occupied by reprints of scientific papers from various sources, such as "Nature," the Royal Institution, the British Association for the Advancement of Science, the Chemical Society of Washington, "McClure's Magazine," the American Association for the Advancement of Science, etc.; this part of the book is called the "General Appendix." The papers are on widely different branches of science, principally physics, chemistry and geology, some natural history and even a little engineering.

For a person with an omniverous appetite for science the book is an extremely interesting one, but owing to the very large amount of matter it contains, and the wide variety of subjects, it is impossible in a review of this kind to give even a synopsis of the contents. A few of the papers, taken at random, are "The Wave Theory of Light," by A. Cornu; "A Field of Experimental Research," by Elihu Thomson; "Relation of Motion in Animals and Plants to the Electrical Phenomena Which are Associated with It," by J. Burton-Sanderson; "Scientific Thought in the Nineteenth Century," by William North Rice, and "A Century's Progress of the Steam Engine," by R. H. Thurston. These form only a small part of the contents.

NOTES.

Telephone Exchange Equipment Wanted.—The Home Telephone Company, Jamestown, N. Y., is about to put in a 1500-line telephone exchange, and is in the market for the entire equipment of instruments and lines; the lines will include several miles of underground construction.

Electric Locomotive for Mountain Railways.—A new type of electric locomotive has been developed recently by Brown, Boveri & Co., Baden, Switzerland, for combination service on steep grades and ordinary track. The locomotive is equipped with two sets of motors, one pair of 25-h.p. machines being arranged to drive ordinary traction wheels, and a single 150-h.p. motor being adapted to drive a gear meshing with a rack laid between the track rails. The gauge is one metre (39.37 ins.), and the locomotive weighs 12 metric tons (about 13¼ short tons). For all service up to grades of 6 per cent, only the two motors driving the traction wheels are used; for heavier grades the rack motor is brought into play. The motors are all direct-current machines designed for 500 volts potential. The locomotive is said to be capable of hauling a load of 28 metric tons (about 30⅞ short tons) up a 19 per cent grade at a speed of 9 kilometres (5.6 miles) an hour.

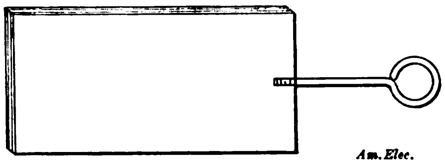
National Electrical Contractors' Association.—The success of the New York State Association of Electrical Contractors led to the issuance of a call for the formation of a national association on July 17 of the present year. In response to this call representatives of the various contractors' associations throughout the country met at Buffalo, and the preliminary details relating to the formation of the national association were perfected there. The National Association now comprises the New York State Association, Pennsylvania State Association, Maryland State Association, St. Louis Electrical Exchange, Detroit Contractors' Association, Minnesota State Association, New England Contractors' Association and several other smaller organizations. It is the purpose of the national body to form State associations in all of the different States, the individual State organizations to be members of the national body. The project is meeting with a great deal of encouragement all over the country, and there is every reason to believe that the ideas of the organizers will be successfully consummated.

More Valuable Information.—The New England newspaper whose reference to a storage-battery plant was reprinted in our last number has burst forth again, the latest technical scintillation being as follows:

> The storage battery at the auxiliary station of the railway is expected to give a working energy of 650 volts and can be charged up to about 1800 when up to its extreme limit. The company expects to save about 80 per cent of the power expended at the power house by the use of this storage battery, whereas now only about 40 per cent is utilized at this end of the line.

Our vocabulary fails.

Increasing the Life of Copper Brushes.—The Market Street Railway Company, of San Francisco, has in its power house some Siemens & Halske generators on which are used copper brusnes, and these wear out rapidly on account of the peculiar construction of the generator, which makes it next to impossible to keep a smooth commutator surface. The brushes cost $1.50 each, and wear out so rapidly that any increase in their life amounts to something financially. A plan has been adopted, therefore, for increasing the useful life of the copper brushes considerably. This consists in drilling and tapping the brush to receive a handle of the form indicated in the accompanying sketch. With this handle on the brush it can be fed much further down into the brush-holder than before, and still be removed for cleaning and surfacing.



METHOD OF INCREASING THE LIFE OF COPPER BRUSHES.

Rebuilding Old Arc Dynamos.—An instructive lesson for superintendents of small arc lighting stations is afforded in the policy adopted by the Capitol Electric Company, Springfield, Ill., with regard to some old-style arc dynamos with which the station was originally equipped. These were Standard machines built to supply 80 9.6-ampere open arc lamps. The armatures were originally wound with 144 coils of No. 15 double cotton-covered wire, each coil containing 42 turns; these were replaced by the same number of coils of No. 16 cotton-covered wire, each coil having 52 turns. In rewinding the machines it was found necessary to increase the insulation on the armature core, which was done by putting on five layers of mica and red fiber paper, each layer being 10 mils thick. The commutators were also rebuilt and changed in form from the open type with air spaces between the segments to the ordinary solid construction of copper bars separated only by mica insulation. It was not found necessary to change the field winding at all. After the foregoing changes in the armature construction were made, each machine supplied 80 enclosed arc lamps, requiring 70 volts and 6.6 amperes each. Mr. E. Holcomb, general manager of the company, states that since reconstructing the armatures and commutators the station records show an almost entire absence of trouble with the arc machines. All of the work was done by regular employees of the company under Mr. Holcomb's direction.

Extension of the Snoqualmie Falls Power Plant.—Two years have passed since the first current from Snoqualmie Falls was carried into the cities of Seattle and Tacoma, Washington, and in this short time the initial installation has proven too small. The capacity of the plant, therefore, is to be enlarged to meet the increasing demand for power. At the falls, distant 44 miles in an air line from Tacoma, and 32 miles from Seattle, are installed in a rock-excavated chamber four generating units, each consisting of a water-wheel direct-connected to a 2000 h.p. Westinghouse three-phase alternator. This famous power transmission system, now generating and distributing 8000 electrical horse-power, is to be more than doubled in capacity. At the same transmission voltage now employed, 30,000 volts, it is proposed to carry 12,000 horse-power more into the cities of Tacoma and Seattle, making the total output 20,000 electrical horse-power. All of the new electrical machinery is to be Westinghouse. The present underground generating station, which is 200 ft. long, is to be lengthened out 150 ft. up stream to make room for the new equipment. A new penstock is to be built, which will carry 50 per cent more water than the old one. The transmission line that is to parallel the old line will require 125 tons of aluminum wire. The work is to be vigorously prosecuted, and it is expected that the first of the new generators will be delivering current into Seattle and Tacoma within the next nine months. The generating machinery will consist of three 3000-kw. rotating-field alternators generating three-phase currents at 1100 volts and 60 cycles, running at 100 r.p.m. For exciting these three generators a 200-kw. multipolar direct-current dynamo is to be used. At 175 r.p.m. it is to deliver under normal load a current of 1600 amperes at 125 volts.

The generator currents at 1100 volts are to be raised to 30,000 volts by nine 1000-kw. oil-insulated, water-cooled transformers, to be delta-connected on both the primary and secondary sides. Instead of the usual equipment of synchronizing lamps, a synchroscope will be employed. Non-automatic circuit-breakers are to be used.

ESTABLISHED 1889.

American Electrician,

WITH WHICH IS INCORPORATED
Electrical Industries.

CECIL P. POOLE, Editor.
W. H. ONKEN, Jr., Associate Editor.

Published on the first of each month by the
American Electrician Company,
NEW YORK: 120 Liberty Street.
CHICAGO: Monadnock Block.
PHILADELPHIA: 929 Chestnut Street.
LONDON: Hastings House, Norfolk Street, Strand.

James H. McGraw, President.
A. E. Clifford, Vice-President.
C. E. Whittlesey, Treasurer.
E. E. Wood, Secretary.

Subscription, - $1.00 Per Year.
In the United States, Canada and Mexico.
Foreign Countries, $2.00.

NOTICE TO ADVERTISERS.

Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

IMPORTANT NOTICE.

Intending subscribers are warned not to place subscription orders with persons who cannot show written authority to take such subscriptions and make collections therefor, as the paper will not undertake to fill orders placed with alleged agents acting without such written authority.

Subscribers requesting a change of address should invariably furnish both the old and the new address.

Vol. XIII. OCTOBER, 1901. No. 10

The American Electrician has a larger paid subscription list than any other electrical journal in the world.

CONTENTS

The Remodeled Plant of the Georgia Electric Light Company 465
Transformers, by A. S. M'Allister 471
The Use of Cooling Towers, by B. Franklin Hart, Jr. 474
Commercial Forms of Cooling Towers, by C. W. Obert 475
The New Chief Engineer, by E. D. Williams 478
Plant of the Urbana (Ill.) Light, Heat & Power Company, by W. H. Zimmerman 482
Loss in Economy by the Inefficient Combustion of Fuel, by A. Bement 484
Coal-Handling Machinery in Central Stations, by F. L. Hutchinson 486
Abstracts from Foreign Contemporaries 491
Some Recent Electrical Patents 494
Hints on Laying out a Station 495
Prof. Pupin's Discovery, by Daniel Higham 496
New Books 496
Notes 497
Editorial 498
The Construction of a Current and Potential Indicator 500
Electric Motor Testing Without a Dynamometer 501
Freaks Due to Reversal of Line Polarity, by E. C. Parham 502
Calorimetry, by Chas. L. Hubbard 503
The Steam Turbine for Dynamo Propulsion 504
Practical Demonstration in Boiler Economy, by C. Watson 506
Lessons in Practical Electricity 507
Letters on Practical Subjects 508
Electrical Catechism 509
Queries and Answers 510
Selective Signaling System for Telephone Party Lines 511
Automatic Coal-Weighing Scales 511
Symmetrical Distribution from Incandescent Lamps 513
New Apparatus and Appliances 514
Handy Tables for Engineers Adv. 37
Obituary Adv. 37
Personals Adv. 37
Trade Publications Adv. 38
Business News Adv. 38

The Lessons Department.

Since this department was established, the number of readers of this paper has been very greatly increased, so that many of our present readers who find the Lessons helpful have been at a disadvantage. On this account the Lessons Department was turned back to the very beginning, in the last issue. From now on, the Lessons will progress in regular sequence, treating all of the essentials of practical electrical engineering, and advancing steadily in grade until the whole range of applied electricity, in the heavier branches of work, has been covered.

◆

Boiler Furnace Performance.

While it originally referred to less grimy and more pleasurable methods, the old saw concerning the deplorable facility with which riches are wont to vanish was never more completely vindicated than in the case of an improperly-fired boiler furnace. An effective step in the direction of curbing notorious waste of fuel was taken when the idea of the automatic stoker was conceived, but this admirable appliance is only an improvement—although a great one—and not a complete cure. Any effort to improve the combustion of coal in a furnace without some means of ascertaining first just how incomplete the process is and afterward just what the effort at improvement has effected is somewhat similar to dosing a sick man with general remedies in ignorance of his ailment.

In order to secure the maximum effect from the combustion of coal in a furnace, every atom of carbon in the coal must be united with two atoms of oxygen taken from air supplied for this purpose; the resultant gas is carbon dioxide (CO_2). Any atoms of carbon not supplied with sufficient oxygen will be unburned and combine with the oxygen to form carbon monoxide (CO); the carbon thus combined will be entirely wasted. It might appear from this that it is only necessary to "flood" the furnace with air so as to furnish an ample supply of oxygen, but this is also wasteful because the surplus air absorbs and carries out of the chimney heat that should be applied to the boiler surfaces. Moreover, the failure to burn all the carbon is not due to lack of primary air supply; no matter how much oxygen may be delivered to the furnace, unless the coal is properly distributed and exposed to the incoming air, more or less of the carbon will fail to combine with the full proportion of oxygen necessary to complete combustion. This is the commonest result found in actual practice, and is indicated by the presence of carbon monoxide and an abnormal surplus of oxygen in the flue gases. There will always be some surplus oxygen, for the reason that about twice as much air is required under the conditions of practice for the complete combustion of coal as would be required if absolutely perfect intimacy between the oxygen in the air and the carbon in the coal could be assured. In order to determine the firing efficiency, therefore, it is necessary only to ascertain the proportion of carbon monoxide, carbon dioxide and free oxygen in the flue gases.

As pointed out on another page, there are several appliances available by means of which flue gases may be analyzed sufficiently to show the degree of thoroughness to which combustion is carried, and there are no great difficulties involved in the use of at least two of these forms of analyzing apparatus. The fact that they are "scientific" appliances need not deter anyone of average intelligence and mental training from their use; so far as the manipulation of the apparatus is concerned it is no more scientific or difficult of application than a steam engine indicator, if as much so.

◆

A Remodeled Central Station.

The progress of central station practice is scarcely ever so clearly illustrated or forcibly emphasized as by the comparison of a modernized plant with its equipment prior to the change; the contrast is nearly always startling and sometimes ludicrous. The principal feature of such changes is generally the displacement of a large number of small engines and dynamos of widely varying types by comparatively few generating units of large output and uniform types. It is not infrequently the case that remodeling a station affords opportunities for the display of much ingenuity in devising special arrangements of circuits or combinations of apparatus. The Atlanta plant, which forms the subject of our leading article this month, appears to have been of this class. One rather unusual feature of the plant is the arrangement of the constant-potential arc lighting circuits; instead of carrying out two wires from the sub-station for each circuit, a single wire, leading out from one of the outer bus-bars of the three-wire system, was carried out to each group of lamps, the return being effected by connecting the other side of the group to the neutral feeder wire of the three-wire system at its nearest point. The neutral conductor, which would otherwise be almost idle normally, is thus utilized more fully, and each of the arc circuits is simplified between the switchboard and the lamp nearest the station.

Another point not common in central station practice is the provision for taking care of any unbalancing of the direct-current three-wire system at such times as the storage battery may be disconnected from the main bus-bars. This consists of carrying leads from the neutral busbar of the system (the outers of which are supplied from rotary converters) to points midway between the terminals of the secondary windings of the transformers which supply the converters. The result is almost equivalent to the effect obtained by supplying a three-wire alternating-current system from a single transformer, tapping the neutral into the middle of the secondary winding. The amount of unbalancing permissible with the Atlanta arrangement is not so great as with alternating-current distribution supplied direct from the transformer, but it is ample for all practical purposes and immensely preferable to the use of auxiliary machinery for balancing (or, more accurately, to allow unbalancing).

◆

Alternating Current Frequency.

The determination of the proper frequency for general alternating-current working, being a compromise between conflicting conditions, is by no means an easy task. Transformers for high frequencies are lighter and cheaper to build than those for low frequencies; arc and incandescent lights are a nuisance on low-frequency currents. On the other hand, high-frequency generators and converters are more expensive, and the operation of high-frequency motors and converters is not precisely ideal. In the effort to effect a practical compromise between the two extremes, frequencies of 40, 50 and 60 cycles have been extensively employed, the most common in this country being 60 cycles.

Now, it is has been found by experienced engineers, pre-eminently capable of investigating the subject, that the design of a 60-cycle rotary converter that will work smoothly under all average conditions is a problem replete with well-nigh insuperable difficulties; whereas a perfectly satisfactory 40-cycle converter is easily produced. Moreover, all translating apparatus thus far developed will work satisfactorily on a 40-cycle circuit, including the mulish synchronous motor and its consistent offspring, the converter. The only obstacle, so far as we can learn, to the adoption of 40 cycles instead of 60 as a general standard is the extra weight and cost of the transformers, so that the matter appears to be simply a question whether or not the extra cost of the transformers would be compensated by the reduction in cost of generators and converters, combined with the improved performance of the latter. The operation of lamps and induction motors does not enter into the choice between 40 and 60 cycles, as they work as well on one as on the other frequency.

It would seem a logical deduction, from the foregoing, that for plants requiring rotary converters the frequency of 40 cycles is very much to be preferred, while plants of a less diversified character might be equipped advantageously with apparatus of higher frequency—say 80 cycles; there appears to be no valid excuse for the adoption in new plants of frequencies above 80. Should an 80-cycle plant ultimately develop work for a rotary converter, a motor-generator set would undoubtedly fill the requirement, its lower efficiency being more than counterbalanced by other economies due to the use of the higher frequency.

◆

Polarity of Electrodes and Terminals

Students are frequently confused in considering the relation between the terminals of electrical apparatus and the circuit to which the apparatus is connected. The most fruitful source of such confusion is the storage battery, sometimes receiving and sometimes delivering current, as it does. The beginner is apt to reason that if the terminal from which current leaves the battery during discharge is positive, the terminal by which the current leaves during the charging period must be positive, whereas the opposite is true. It will probably be of assistance to the student to remember (1) that the electrical polarity or sign of a terminal never changes so long as the internal arrangement of the apparatus remains unchanged, and (2) that the terminals of any receptive apparatus invariably have the same signs as the parts of the external circuit to which they are connected. Thus, the positive terminal of a storage battery is that at which current passes from the battery when it is discharging; this terminal is invariably positive, whether the battery be charging or discharging, and is always connected to the positive side of the external circuit, whether the circuit be supplying current to the battery or receiving current from it. The same is true of a dynamo-electric machine. The positive terminal is that at which current leaves the machine when it is run as a generator; if operated as a motor in the same direction and with the same polarity of field excitation as before, the terminal formerly positive remains positive and must be connected to the positive side of the supply circuit.

The indiscriminate use of the terms "electrode," "pole" and "terminal" in referring to battery elements, has also been a source of some confusion to electrical students. The carbon of a carbon-zinc cell is loosely termed the positive element, because the current leaves the cell at the carbon terminal. The fact is, however, that carbon is electro-negative to zinc, and the carbon element is therefore really the negative one, considered as an electrode, while the zinc is the positive electrode. The distinction between an electrode and a terminal will be evident, and should be observed in thinking or speaking of batteries. The terminals of a battery were formerly called "poles," but present usage is tending more and more toward the application of this term exclusively to magnets, which is obviously appropriate. This leaves only the general terms "electrode" and "terminal," the former applicable to the carbon, copper, zinc or other metal within the electrolyte, and the latter to the clamp or screw or lug to which the circuit wire is attached. Each element of a battery, therefore, must inevitably have two polarities; if the electrode portion is positive, as in the case of zinc, then the terminal portion must be negative, and *vice versa*.

A more absolute identification of the electrodes or elements of a primary or voltaic cell is afforded by the use of the specific names "anode" and "cathode," as these do not involve definition in terms of polarity. The anode is the element that wastes away during the operation of the battery, and the cathode is, of course, the other element. In the case of storage cells, however, the anode does not waste away, so that it must be identified by its polarity, which is negative at the terminal and positive within the electrolyte.

THE CONSTRUCTION OF A CURRENT AND POTENTIAL INDICATOR.

The accompanying sketches illustrate the essential features of a simple indicator which may be wound either to serve as a voltmeter or potential indicator, or as an ammeter or current indicator. The instrument is intended for switchboard service, and if properly constructed will be sufficiently accurate for ordinary practice. It is of the solenoidal type, the actuating coil being wound on a drum, *d*, Fig. 1, consisting of thin sheet brass (not more than 1/32 in. thick). The outer diameter of the drum is 2 ins., and its extreme length vertically is 1 in. It is supported on a brass base-plate or ring, *b*, ⅛ in. thick, and of the shape and size indicated in Fig. 2, which is a plan view. The base-plate is provided with a wall flange by means of which it can be secured to the baseboard of the instrument. The upper head, *h*, of the solenoid core is also of brass, 1/16 in. thick, with a slight flange around the edge of the central opening, which must be machined to fit the inner diameter of the brass cylinder, *d*.

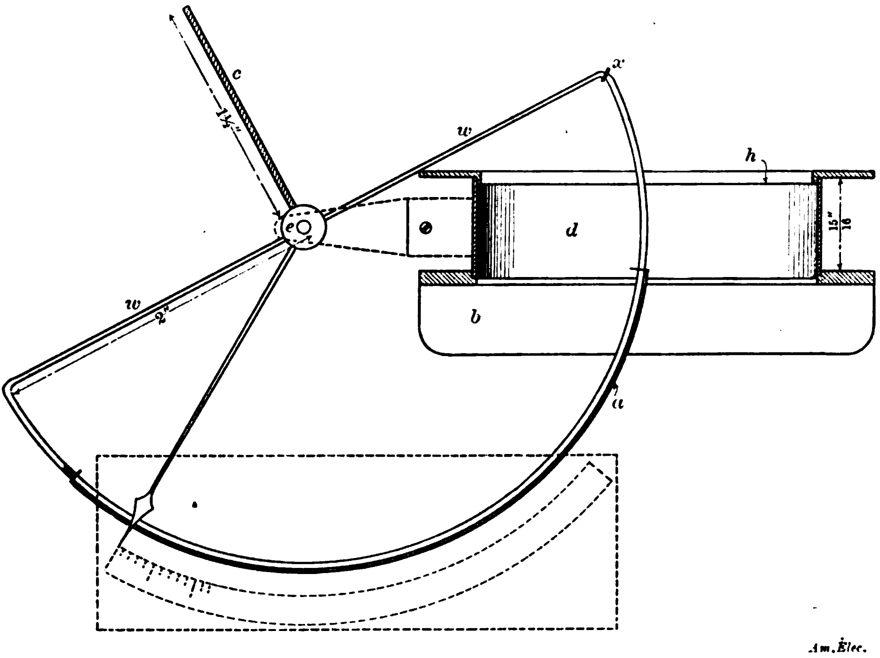


FIG. 1.—MOVING MEMBER AND SOLENOID BOBBIN.

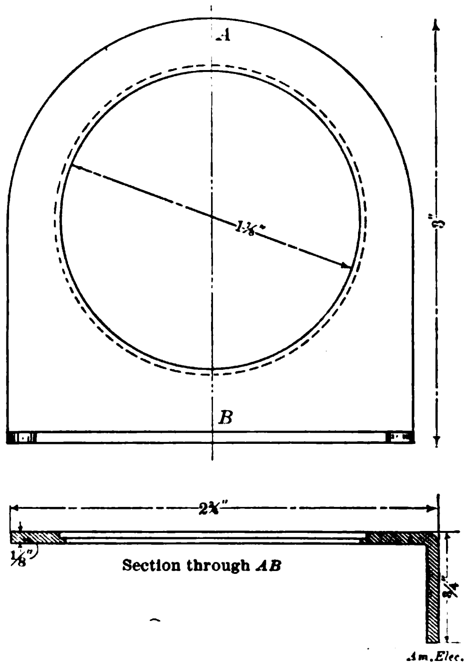


FIG 2.—SOLENOID BASE PLATE.

The moving element of the instrument consists of a thin strip of transformer iron cut to the shape shown by Fig. 3, and mounted on two brass wires, *w*, 1/16 in. in diameter, which are bent to the form indicated in Figs. 1 and 4. The brass wires, *w*, and the armature strip, *a*, must conform to the arc of a 2-in. circle between the points *x* and *z*, Fig. 1. The two ends of each brass wire are secured to a round button, *e*, mounted on the spindle of the instrument. This button is ⅛ in. thick and ⅝ in. in diameter. Fig. 4, showing a plan view of the working parts of the instrument, indicates the distance apart of the two buttons on the spindle. It will not be necessary to fasten the buttons rigidly to the spindle; if the hole through the center of the buttons be made a tight fit on the spindle this will serve all practical purposes, as the torsional strain transmitted from the buttons to the spindle is only that due to the friction of the pivots.

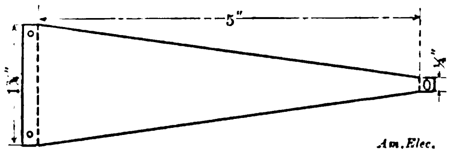


FIG. 3.—SHAPE OF STRIP "A."

The two wires, *w*, on which the armature strips are mounted, must be bound securely at the point, *x*, where they come together at the beginning of the circular arc. The wires are threaded through lips into which the ends of the armature strip are bent, as indicated in Figs. 1 and 3. The armature strip may be secured to the wires by means of a minute drop of solder at the small end of the strip and a drop on each wire at the broad end. Provision is made for adjusting the instrument in the shape of a counterweight stem, *c*, 1½ ins. long and 3/32 in. in diameter, one end of which is inserted in the front button and extending outward at right angles to the straight portions of the two brass wires carrying the armature strip. A small brass nut should be threaded to fit snugly the thread of this stem, so that it will not be liable to displacement by slight jars. The weight of the nut will have to be determined according to the service required of the instrument. It can be ascertained after a few trials with nuts of different thicknesses and diameters; the proper weight to use will be that which, when at the extreme end of the stem, just allows the needle to go to the far limit of the scale when the current (if the instrument is built as an ammeter) or the voltage (if it is built for a voltmeter) is the maximum that is expected to be applied to the solenoid.

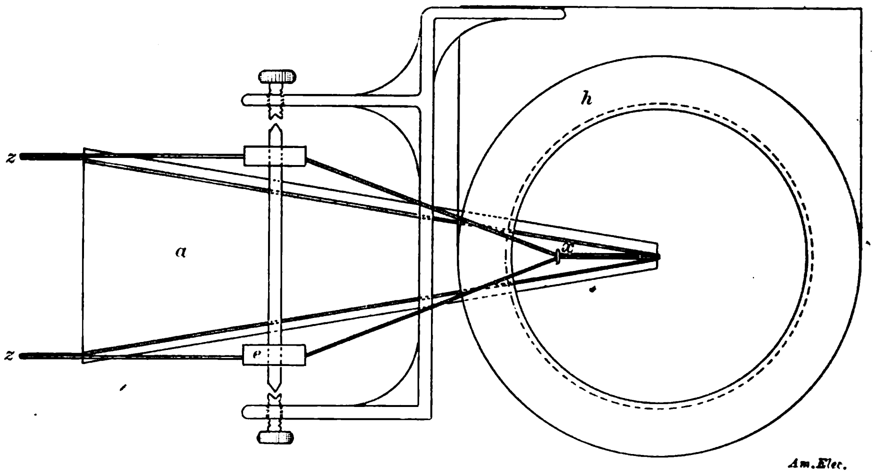


FIG. 4.—PLAN VIEW OF WORKING PARTS.

The pointer is also secured to the front button, *e*, in the same manner as the other wires. It should consist preferably of a round aluminum wire flattened at the outer end and then trimmed to a point. The pointer should be given an offset of ½ in. about 1 in. from the button, so that its lower end will be far enough away from the armature strip to allow a scale card to be mounted in between the two. The position of the scale card is indicated by the dotted lines in Fig. 1; it may be mounted on two brass posts extending outward from the back-board of the instrument. The moving member is supported on a brass bracket of the form shown by Fig. 5, the two lugs of which carry steel screws with cupped ends to receive the pointed ends of the spindle.

If the instrument is to be used as a voltmeter on a 125-volt circuit, the solenoid coil should consist of No. 36 double silk-covered magnet wire, wound to a depth of ⅜ in. and a width of ⅞ in., an insulating ring of fiber 1/32 in. thick being provided at each end of the coil to insulate the ends from the brass heads.

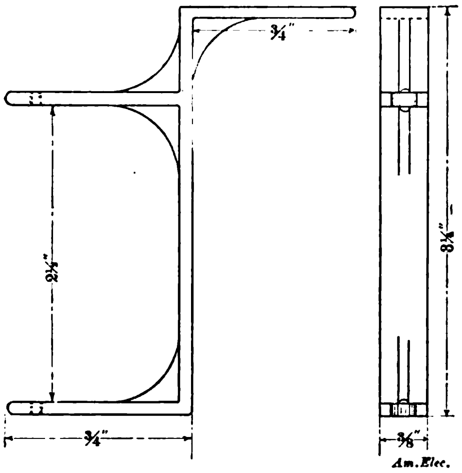


FIG. 5.—BRASS BRACKET

The drum must also be insulated by means of either shellacked linen or fiber paper. By careful winding it should be possible to get 42 layers of wire in the coil, each layer containing 97 turns. In order to adapt the instrument for operation on a 110 to 130-volt circuit, a non-inductive resistance coil must be provided, to be connected in series with the solenoid coil. This can be made of 250 ft. of No. 32 double cotton-covered Climax resistance wire. It will weigh between 1 and 2 ounces only, and must be wound non-inductively by starting the winding at the middle of the total length of wire and winding two strands in parallel.

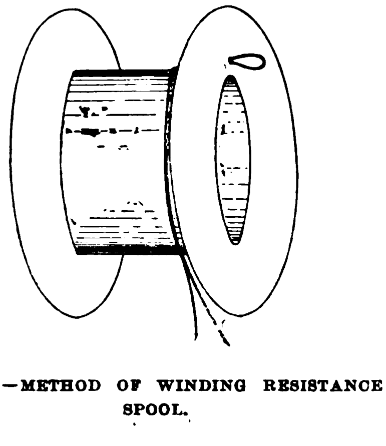


FIG. 6.—METHOD OF WINDING RESISTANCE SPOOL.

This is indicated roughly by Fig. 6, showing the beginning of the winding of the resistance spool at the bight of the wire, which must be midway of its length. The resistance spool may be secured to the backboard of the instrument in any convenient place, and must be connected in series with the solenoid coil. The resistance of the solenoid, if properly wound, should be a trifle over 1000 ohms, and the resistance of the spool of Climax wire should be 2000 ohms, making a total resistance of 3000 ohms. The current therefore at, say, 126 volts will be 0.042 ampere.

If it is desired to use the instrument as an ammeter it may be wound for an arc circuit not exceeding 10 amperes with No. 8 wire, 3 layers deep, with 64 turns per layer. For a circuit not exceeding 8½ amperes, No. 9 wire, 3 layers deep, with 72 turns per layer, can be used, making the instrument more sensitive than with the coarser winding. For a 6.8-ampere circuit No. 10 wire can be used 3 layers deep, with 81 turns per layer. The instrument is intended for use on direct-current circuits only.

The dial of the instrument, which shows the voltage or the amperage, as the case may be, must be calibrated by comparing it with a standard voltmeter or ammeter.

◆

ELECTRIC MOTOR TESTING WITHOUT A DYNAMOMETER.

The best-known method of testing an electric motor for efficiency is to put an artificial or frictional load on the machine by means of some form of brake dynamometer, measuring the mechanical torque in pound-feet delivered to the dynamometer and the electrical power in watts delivered to the motor from the supply circuit; multiplying the pound-feet by the revolutions per second and dividing by the watts gives the percentage of intake that the motor is able to convert into useful work. This method is simple enough, and if one has a reliable Prony brake and is experienced in the use of it, there is nothing more to be desired.

Central station superintendents who have not a sufficient amount of motor testing to do to justify the expense and application of a good brake dynamometer, and yet have occasion to test a motor now and then, will find the following method useful: (1) Connect the motor to a supply circuit of the proper voltage, or of a voltage a trifle higher than that at which the motor is rated, putting an adjustable resistance in series with the machine, and an ammeter in the armature circuit. Run the motor free, with all of the starting box resistance cut out, and adjust the auxiliary resistance until the voltage at the motor terminals is precisely the rated voltage of the machine; represent this by *E*. Then measure the armature current, and represent its value by *c*.

(2). Next, and immediately, stop the motor, secure the armature shaft so that it cannot turn, and connect the brushes to the circuit again through a resistance by means of which the armature current can be adjusted to the value, *c*, which it had when the armature was running free; then measure the volts at the brushes, and represent them by *v*. Subtract this voltage from the rated voltage, *E*, and multiply the difference by *c*; the result will be the armature core and friction losses in watts, thus:

$$(E - v)\ c = w,$$

and the resistance of the armature circuit may be taken as equal to

$$\frac{v}{c} = r,$$

without important error. In making the test just mentioned, care should be taken to prevent the armature current at any moment from exceeding the value, *c*, obtained running free.

Now, if the rated output of the motor, reduced to watts, be represented by *W*, the following formula will give the armature current at which this rated output will be obtained:

$$C = \frac{E - \sqrt{E^2 - 4\ (W + w)\ r}}{2\ r} \ldots (1)$$

The efficiency of the machine, then, will obviously be

$$\frac{100\ W}{E\ (C + C_f)} = \text{Per cent. eff.} \ldots (2)$$

Here, C_f represents the current in the field winding at rated voltage, which can be readily measured.

Example: A 220-volt motor rated at 10 horse-power shows the following values: Armature current running free, 2.4 amperes; field current, 1.1 amperes; volts at the brushes, with armature stationary, ¾ volt. These figures give the following values to the symbol letters:

$E = 220,$
$W = 7460,$
$c = 2.4,$
$v = 0.75,$
$w = 510,$
$r = 0.3125,$
$C_f = 1.1.$

Substituting in formula (1):

$$C = \frac{220 - \sqrt{48{,}400 - 4(7460 + 510).3125}}{.625} = 38.31.$$

This is the full-load armature current, and the efficiency, according to formula (2), will be $\text{Eff.} = \frac{746{,}000}{220\ (38.31 + 1.1)} = 86$ per cent (and a trifle over, the accurate figure being 86.037).

Formula (1) may be reduced to a somewhat better expression so far as the actual work of computation is concerned; thus:

$$C = \frac{E}{r} \times \left(0.5 - \sqrt{0.25 - \frac{r\ (W + w)}{E^2}}\right)$$

The formulas for full-load current are based upon the assumption that the core losses, armature, friction, windage and pole-piece eddy-current losses all remain constant from no load to full load. While this is not strictly true, the error introduced is practically negligible.

FREAKS DUE TO REVERSAL OF LINE POLARITY.

BY E. C. PARHAM.

Ordinarily we are taught to believe that the question of polarity is a relative one and that in most cases it is a matter of little import to us which way the current flows in a circuit. As some great minds have worried over the problem without giving to the world any convincing arguments one way or the other, we must content ourselves with the conclusion that polarity is relative, but we must be a little careful in some cases how we handle this relation. It is now commonly agreed among railway men to make the trolley wire positive and the rail negative, and to assume that the current flows from the trolley wire to the ground. Accordingly the positive terminal of the dynamo is, as a rule, connected to the wire, and the negative terminal to the rail. That this condition is not always maintained by frequently testing the polarity and reversing it if necessary, the two instances cited herein will show.

In Fig. 1, *a*, *s* and *r* are, respectively, the armature, series field and shunt field of one dynamo, in a station, *A*, and *a'*, *s'* and *r'* are, respectively, the armature, series field and shunt field of another dynamo, in a station, *B*. The two dynamos in question were the entire equipment of the two power houses, *A* and *B*, situated about three miles apart, one dynamo being in each power house. The two roads were at first owned by separate companies but in the course of time one absorbed the other. The two trolleys were then connected together with a section insulator or line breaker, and each dynamo supplied its own section of the road. The motormen all had orders to throw the power off when they passed the section insulator, in order to save it from the burning due to the arc that is drawn if the power is kept on when passing. Once in a while a motorman would forget to throw off the power, and when he did so there would be fireworks overhead, and the power would go off the line. The dynamo at *A* was one-half larger than the dynamo at *B*, so that in case of trouble involving both machines the one at *B* always threw out its circuit-breaker. The trouble herein described was caused by the polarity of the machine at *A* being reversed. It is easy to see that if both machines were run at the same voltage and both were of the same polarity (both having their positive sides to the trolley wire) the difference of potential across the line-breaker, *x*, would be little or nothing, because there would be only that difference due to the difference in loss between the two power houses and the breaker. Sometimes this loss would be in favor of one side and sometimes in favor of the other, according to the load that each was carrying.

Now suppose, as was actually the case, that one machine has its polarity reversed in some way or other; the effect of this change is to put the unlike sides of the two machines together, as shown in Fig. 1, thus fulfilling the definition of two machines in series; that is, they are so connected that their voltages add together. If there were a good line breaker at *x*, and no cars were permitted to run over it with the current on, it would make no more difference in the running of the two lines than if they were thousands of miles apart, because the two circuits have only one point in common, namely, the ground; and this is in common to every grounded track-return trolley road in the world. But it must be borne in mind that with the two dynamos in series there is 1000 volts difference of potential across the line breaker, *x*; 10 railway lamps will light up to full candle-power across it. If a car comes along and runs over the breaker with the current on, an arc follows the wheel and the two potentials get together through the arc; 1000 volts would not jump across the breaker without assistance, but it will maintain an arc along a path already provided. As soon as the arc connects the two lines together there are 1000 volts sending a current through the line, rails and two dynamos in series. The combined resistance of all of them is very low and the current enormous. There are two circuit-breakers in the short-circuit and the one that is set for the lightest load blows; this is, of course, the circuit-breaker on the small machine, but in many cases both blow when the large circuit-breaker is in good working order and the small one is a little slow in action. Of course, when the two go out, the whole line is dead. On one occasion, in the case related, the small circuit-breaker acted first, but was unable to break the large current supported by 1000 volts, so the large one went out also, but not until the small one was ruined.

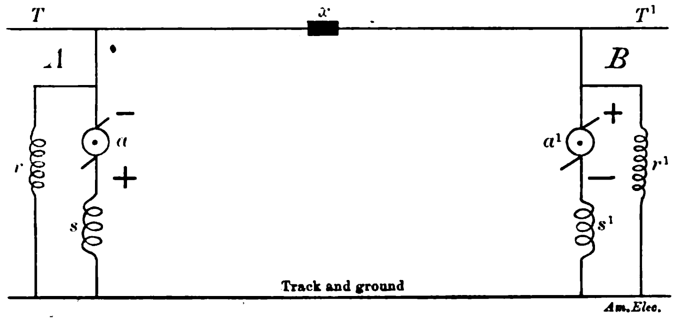


FIG. 1.—DIAGRAM OF CONNECTIONS.

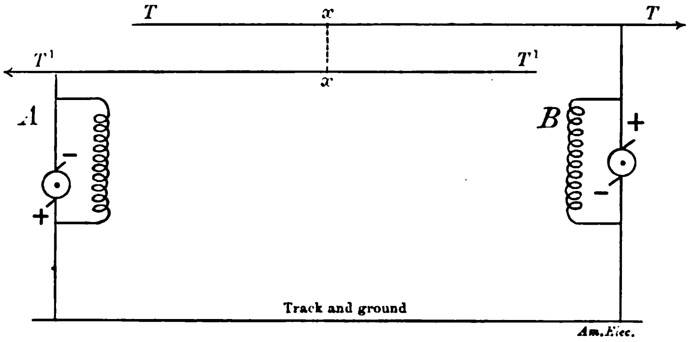


FIG. 2.—TAPPING FEEDER WIRES.

Fig. 2 is intended to indicate the following condition: Two country roads coming from opposite directions had their termini at the same point and depot. Their trolley wires were dead ended to the same pole. The dynamo, *A*, of one railway was driven by a steam engine, but the other one, *B*, was driven by a water-wheel which was fed from a mountain stream that sometimes had lots of water in it and sometimes had very little. Very often when the water station was short of power the linemen would run a temporary jumper to the wire of the other road and "borrow" power for a while, till the rush was over. This systematic thieving was carried on for a year or more before it was discovered, and then it was found out by accident. The polarity of the steam-driven machine, *A*, became reversed, either by accident or by design, and one day when a lineman was about to make the usual connection for helping his folks out in a pinch, there came such a flash that, in his surprise, he fell off his ladder and broke a leg. In the diagram, *T′ T* is the trolley wire fed by the water-driven dynamo, and *T″ T″* the wire fed by the engine-driven dynamo; *x x* is the wire that the lineman was accustomed to string when his road needed power. It is not hard to see that with the polarity of one machine reversed, the two machines are in series instead of in multiple as soon as the connection, *x x*, is made, establishing a closed circuit of extremely low resistance subjected to 1000 volts. On this occasion the circuit-breakers on neither machine acted because they did not have time, as it seems that the lineman pulled the wire loose instantly before he started to drop.

The reversal of polarity by a dynamo is a very odd occurrence. Where there are several machines running in multiple, trouble due to reversal is not apt to occur if the dynamo tender is experienced and careful, because the machine first started up excites all the rest, and their polarity is bound to be right if the connections are right. Dynamos standing side by side but running on different lines sometimes influence each other; stray magnetism from one will neutralize and reverse the magnetization of the other, if through vibration that magnetization becomes very weak. A discharge of lightning will sometimes reverse the polarity of an idle machine. One of the most frequent causes of the reversal of the polarity of a dynamo is breaking the field circuit too suddenly. Why this causes reversal of residual polarity seems as yet to be an unsettled question.

Another instance of deplorable results from the reversal of line polarity was afforded by the case of an enterprising boy who had a plating bath that drew its current from a trolley wire. He did a land-office business and made considerable money, but a large slice of his profits was neutralized when the line polarity reversed one night and allowed the bath to eat up about three dozen tablespoons. We are free, then, to draw the conclusion that sometimes it is well to think a little about polarity.

◆

CALORIMETRY.

BY CHAS. L. HUBBARD.

THE BARREL CALORIMETER.

As stated in a previous article, steam may be either "superheated," "dry and saturated" or "wet." Moist or wet steam is made up of a mixture of dry steam and water in the form of a fine mist or spray. The percentage of dry steam in the mixture is called the "quality" of the steam; that is, if a given quantity of steam as taken from a boiler is found to contain 96 parts of dry steam and 4 parts of water in the form of spray, the quality of the steam is said to be 96 per cent or simply 96. The process of determining the quality of the steam, termed "calorimetry," is of much importance in connection with efficiency tests of boilers and engines, as only dry steam is of value for doing work in the engine or for heating purposes. There are several different methods of determining the quality of steam, the more common being by means of the "barrel" calorimeter for rough work, and the "separator" and "throttling" calorimeters for more accurate work.

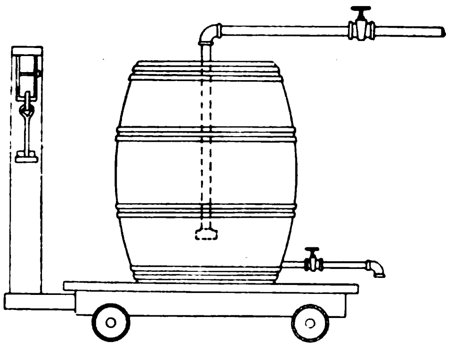


FIG. 1.—BARREL CALORIMETER.

The barrel calorimeter is shown in Fig. 1, and consists of an ordinary wooden barrel placed upon platform scales and connected with the steam pipe by means of a hose or hose and iron pipe. The barrel should be provided with means for filling with water and for emptying; a Fahrenheit thermometer, reading to 1/5 of a degree, and having a range from 32° to 212°, will be necessary. The method of procedure is as follows: Fill the barrel three-fourths full of water and heat it to a temperature of about 130°; draw this water off without taking any further measurements, as this is simply to warm up the barrel. Next weigh the barrel and quickly fill it with a known weight of water and take its temperature. Then blow steam through the pipe to warm and dry it, insert it in the barrel, as shown, and turn on steam, allowing the steam to blow into the water until the latter reaches a temperature of about 110°, meanwhile noting the average steam pressure in the pipe. The pipe is then removed, the water stirred vigorously, and the final temperature and weight taken.

We now have the following data from which to compute the quality of the steam: Weight of condensing water before and after steam was admitted, temperature of condensing water before and after steam was admitted, and the pressure of the steam. The weight of the condensed steam is equal to the increase in weight of the condensing water, and the heat given up by the condensed steam is equal to the "latent heat" of the dry steam plus the "heat in the liquid" of both the dry steam and the entrained water. If the "latent heat of evaporation" of the steam supplied to the barrel at the pressure noted be represented by L; the "latent heat in liquid" of both the steam and the entrained moisture delivered with it be represented by S; and the quality of the steam by x, then the number of heat units given up to the condensing water by the condensation of each pound of steam is expressed by the equation:

$$x\,L + S = h \ldots\ldots\ldots\ldots (1)$$

As the heat given up by the condensed steam is used in raising the temperature of the condensing water, its total amount can be easily computed; it is equal to the weight of the condensing water multiplied by its rise in temperature, and this divided by the weight of condensed steam will give the heat absorbed by condensing in it one pound of steam. This is expressed in formula shape as follows:

$$\frac{W\ (t_2 - t_1)}{w} = H \ldots\ldots\ldots\ldots (2)$$

in which W represents the weight of the condensing water in the barrel, t_1 the temperature of this water just before the steam was turned into it, t_2 the final temperature of the water and condensed steam, and w the weight of the steam condensed, H being, of course, the number of heat units absorbed by the condensing water, due to the condensation of one pound of steam.

The "heat in the liquid" as given in most steam tables is reckoned from the freezing point, or 32° above zero, so that the quantity of heat represented by equation (1) would only be given up by cooling the steam down to this temperature. If the steam is only cooled to some point above 32° the heat given out by one pound will be very nearly equal, in thermal units, to the latent heat plus the difference between the initial and final temperatures in degrees. Substituting this value in equation (1) we have the following:

$$x\,L + t - t_2 = h \ldots\ldots\ldots\ldots (3)$$

in which t is the temperature of the steam at the pressure noted while it was being delivered to the barrel. As the heat units, h, given up by the steam in condensing are equal to the heat units, H, absorbed by the condensing water, the left-hand members of equation (2) and (3) must be equal, thus

$$\frac{W\ (t_2 - t_1)}{w} = x\,L + t - t_2$$

In order to ascertain the quality of the steam being tested, this latter equation must, of course, be transposed so as to solve for x; thus

$$\frac{W\ (t_2 - t_1)}{w} - (t - t_2) = x\,L$$

and

$$\frac{\frac{W}{w}(t_2 - t_1) - (t - t_2)}{L} = x \ldots\ldots (4)$$

This may be also written:

$$\frac{\frac{W}{w}(t_2 - t_1) + t_2 - t}{L} = x \ldots\ldots\ldots (5)$$

Either of these may be used as the working formula in connection with the barrel calorimeter.

Example: The intial temperature (t_1) of the condensing water is 52.8° and its final temperature (t_2) is 109.6°. The steam pressure by gauge is 79.7 lbs., or 94.4 absolute, so that its temperature (t) is 323.5°. The initial weight of the condensing water is 360 lbs.; the final weight is 379.1 lbs. From the above data and by the use of steam tables, the values of all the symbols may be filled in as follows:

$W = 360$
$w = 379.1 - 360 = 19.1$
$t = 323.5°$
$t_1 = 52.8°$
$t_2 = 109.6°$
$L = 888.2$

Substituting these values in formula (5) we have

$$x = \frac{\frac{360}{19.1}(109.6 - 52.8) + 109.6 - 323.5}{888.2} = 0.964,$$

which is the quality of the steam; expressed as a percentage this would be 96.4 per cent, of course. The percentage of moisture in the steam, therefore, is $100 - 96.4 = 3.6$ per cent.

Instead of removing the steam pipe from the barrel each time the water is weighed it may remain in the water, provided it is so supported externally that its weight will not enter into the calculations. A small pet cock should be connected into the pipe next the valve on the side toward the barrel, so as to admit air to the pipe before each weighing, in order that water may not be drawn up into the pipe. A tee on the end of the pipe forms an efficient agitator, provided the temperature is taken immediately after the steam is shut off.

THE STEAM TURBINE FOR DYNAMO PROPULSION.

Since the advent of the dynamo, there has been felt the need of a prime mover embodying high speed and fairly high efficiency, but not restricted by the disadvantages of the steam engine with reciprocating parts. The steam turbine, which has been brought into practical form by recent engineering developments, is meeting these requirements, and is offering some other advantages in addition. It has inherently very high speed and is devoid of reciprocating parts, and many turbines installed and operating under the conditions of actual service are proving to be as efficient as the best reciprocating engines. In addition, it avoids other disadvantages of the reciprocating engine by the total elimination of rubbing surfaces and the lubrication required by them, and by the elimination of heat losses from the condensation and reevaporation of steam due to wide temperature fluctuations in the cylinder walls of engines working expansively. And, furthermore, it realizes practically adiabatic expansion of the steam, the ideal condition so sought for in the reciprocating engine.

A steam turbine consists of a small turbine wheel that runs by steam in much the same manner as the ordinary hydraulic turbine runs by water pressure, the principle of operation being the same in both cases. The wheel of the turbine is rotated either by the impact from a steam jet upon revolving blades or vanes, or by the reaction of a jet of escaping steam on the wheel. Constructional differences are, however, at once met in passing from the hydraulic to the steam turbine on account of the great velocity with which steam flows through an orifice as compared with water. For instance, 100 feet per second is a very high velocity for water flowing from an orifice, while steam at any pressure above 25 lbs. per square inch flows from an orifice into the atmosphere at a velocity of nearly 1,500 ft. per second. In order to utilize so great a velocity efficiently, it is necessary to adopt an extraordinarily high speed for the turbine wheel, a speed so high that particular attention must be given to the construction of the wheel in order that its strength may be sufficient to withstand the centrifugal force.

Such methods of utilizing the kinetic energy of steam issuing from a jet are by no means new. The earliest steam engine, historically, was a steam reaction wheel described by Hero in 120 B.C., while Branca, in 1629 A.D., proposed an engine on the impact turbine principle. Tournaire, in 1853, discussed a proposed form of steam turbine from the point of view of applied mechanics, although nothing was done in a practical way until some years later, when Mr. Chas. A. Parsons, of England, constructed an experimental reaction turbine operated by two steam jets, with the wheel enclosed in a casing so that the exhaust from the jets might be disposed of by a condenser. This early turbine produced very encouraging results, developing, with a pressure of 100 lbs. and a 26-in. vacuum, 20 horse-power at a speed of 5,000 r.p.m. upon a consumption of 40 lbs. of steam per horse-power-hour; which was remarkable in view of the crudeness of construction.

There are two types of steam turbines: impulse turbines and reaction turbines. An impulse turbine is one in which the turbine wheel is rotated by the effect of steam blowing from jets directly against the turbine wheel vanes, in which the entire available energy of the steam is converted, by its expansion in the jet, into kinetic energy in the form of rapidly moving steam particles. In a reaction turbine, the wheel is revolved by the reaction of one or more steam jets blowing tangentially from the circumference of the wheel, in which only a part of the available energy of the steam is converted into kinetic energy in the form of moving steam particles before it enters the turbine wheel, the remainder of the conversion taking place as the steam leaves the wheel. It is evident from these features that it is not essential for the wheel of the impulse turbine to be entirely filled with steam, while in the reaction turbine the wheel must contain steam jets, or their equivalents, and be entirely filled with steam.

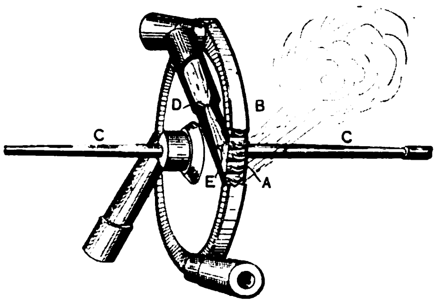


FIG. 1.—DE LAVAL STEAM TURBINE.

It may be here pointed out that the steam turbine differs fundamentally from the piston engine in that the piston engine does work by reason of the static expansive force of the steam acting behind the piston, while in the steam turbine work is developed by the kinetic energy of particles of steam which are given an enormous velocity by the steam expanding from a higher pressure to a lower.

The most noteworthy of the attempts on the impulse type of turbine is the De Laval machine. In its usual form it consists of a disc, or wheel, with a large number of small vanes arranged radially upon its periphery, and one or more steam jets arranged to blow tangentially against these vanes, as shown in Fig. 1. The expansion of the steam, which gives it its high velocity, takes place in the diverging conical nozzle of each jet, the taper of the nozzle bore being so proportioned as to give the steam the proper expansion to cause it to attain its greatest momentum as it reaches the vanes of the wheel. The smallest sectional area of the nozzle, as at *D*, determines the quantity of steam which will pass through it, and it is the ratio of that area to the area at the outer end, as at *E*, which determines the ratio of expansion and thus the velocity of the steam. This is one of the most vital considerations in the design of the turbine as, if the outer end of the nozzle is too small, the steam is not entirely expanded when it reaches the wheel and thus has not attained its greatest velocity; and if the outer end is too large, the steam will not issue in a straight line and in this case also the maximum effect will not be obtained.

The hydraulic prototype of the De Laval steam turbine is the impulse wheel, of which type the Pelton is a representative. As in the case of the hydraulic impulse wheel, in order to obtain the greatest efficiency, the wheel of the steam turbine must run at a speed giving a peripheral velocity about one-half that of the steam as it strikes the vanes. This at once introduces, on account of the excessively high velocity of the steam, extremely high speed for the wheel, as for instance, in order to obtain in a wheel of 10-in. diameter a peripheral velocity of one-half that of the steam from the jet (1500 ft. per sec.), or 750 ft. per sec., it must revolve at the rate of from 15,000 to 20,000 r.p.m., and such speeds are met with commonly in turbine practice. These speeds involve two serious difficulties. First, there are produced such great centrifugal stresses that only the most rigid and perfect construction in the wheel is allowable; second, the impossibility of securing even approximate homogenity of materials renders it impossible to get the center mass of the wheel and revolving parts exactly on the geometrical axis of revolution, so that even with the most careful balancing, an inevitable vibration must be provided for.

In the De Laval turbine, the severe centrifugal stresses are met by extremely strong construction. The wheel is made of the very best quality of steel and the vanes are in one piece with the wheel, being cut from the solid section of the wheel by the milling machine; for further strength as well as protection to the vanes, a steel band is shrunk on over them. In order to provide for vibration due to imperfect balancing, a long flexible steel shaft is used, as shown at *C* in Fig. 1. When the turbine is in operation, the wheel and shaft are actually thrown out of symmetry with their geometrical center and revolve about the center of gravity of the whole mass, the reduced section of the shaft near the bearing shoulders, together with its extreme length, permitting the necessary springing out of line.

As the wheel, in coming up to speed, begins to change from its geometrical axis to its gravitational axis coinciding with its center of mass, a violent vibration takes place, but, after this particular speed, called the "critical" speed, is passed and the wheel is revolving around its true center of mass, it runs smoothly again and no further vibration is felt even at the highest speeds. It has been found that these critical speeds become lower as the weight and radius of the revolving parts become greater.

Nozzles for four steam jets are shown in Fig. 1, but the number of jets may be as many as may be found advantageous. The nozzles are so set as to direct the jet into the vanes from the side, being set at an angle of approximately 20° with the plane of the wheel, and are so directed as to act upon the concave sides of the vanes, which are crescent-shaped in section. The ring which is shrunk on the outside of the vanes for their protection serves also to restrict the steam to action upon the surfaces of the vanes.

The governing of the De Laval turbine may be accomplished either by throttling the steam supply or by varying the number of steam jets, the latter having been suggested as being the equivalent of the cut-off method of governing the piston engine. In practice, however, the centrifugal throttling governor has been largely used, although it seems as though a judicious combination of the two methods would produce almost ideal regulation. For application to machinery, the speed is usually reduced by means of gearing, double right-and-left spiral gears having been used with success in many cases.

One particular advantage that characterizes the De Laval turbine is the fact that the steam has lost its pressure by the time it reaches the wheel, and therefore does not require a close fitting between the nozzle and the vanes. This is an important feature, as it eliminates the necessity of any contact with the wheel and reduces the fitting to the greatest simplicity.

The reaction type of turbine has not been adhered to exclusively in modern practice, but has been developed in combination with the impulse principle, as is exemplified in the Parsons turbine. In this turbine several stationary discs and moving discs are used, arranged alternately in such a manner as to utilize both the reaction and impulse principles. It has been built in two different forms, the "outward flow" form in England, and the "axial flow" form in the United States. In the "outward flow" form several revolving discs are arranged upon a shaft, each disc carrying on one surface several concentric rings of brass blades, traveling in spaces between rings of fixed blades carried on annular discs fixed to the outer case. Each revolving disc forms with its adjacent fixed disc a series of outward flow turbines, the steam entering inside the smallest ring and traveling up to the circumference, thence over and down to the center of the next disc, through the next turbine of the series, and so on to the end of the series, which may be made long enough to allow for complete expansion of the steam. The governor used for this type of turbine consists of a steam relay in connection with the turbine shaft, which opens a double-beat lift valve at rapid intervals. The lift valve controls the steam admission so that steam is admitted to the turbine in periodic gusts, and the governing of the speed under varying loads is accomplished by altering the duration of the gusts as is necessary. The end thrust that would result from the pressure of the steam longitudinally on the discs is counteracted at the high-pressure end of the series by a baffle piston revolving upon the shaft with the discs, which baffle piston has a number of deep grooves on its circumference meshing with corresponding projections from a fixed bushing to prevent escape of steam. Any small amount of longitudinal thrust that may still remain unbalanced is provided for by an adjustable thrust bearing on the shaft.

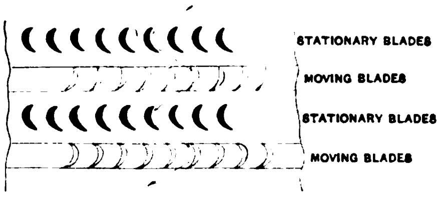


FIG. 3.—TURBINE BLADES.

The axial-flow type of turbine, of which the Westinghouse-Parsons turbine is representative, differs very little from the outward-flow type just described, except in the arrangement of the blades upon the revolving and fixed parts. In Fig. 2 is shown a longitudinal section through the Westinghouse-Parsons turbine illustrating the axial arrangement of the fixed and moving blades. The moving blades are shown therein as rings encircling the enlarged shaft of the turbine, and the stationary blades appear as teeth or projections between the rows of moving blades; but the diagram, in Fig. 3, shows best the relation borne by the moving blades to the stationary blades at all times. The blades are all crescent-shaped in section, but the moving blades are concave on the front side while the stationary blades are concave on the rear side, considering the shaft to rotate from front to rear.

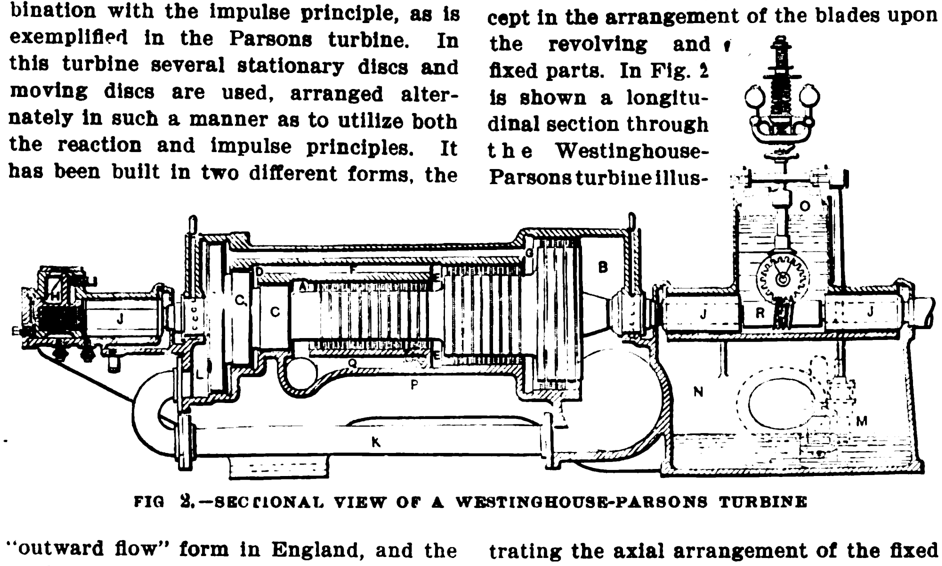


FIG 2.—SECTIONAL VIEW OF A WESTINGHOUSE-PARSONS TURBINE

The passage of the steam through the blades is much the same as in the outward-flow turbine previously mentioned; it passes first between the fixed blades and is deflected against the wheel blades beyond, driving them around, and giving the impulse effect. Then, without having lost much pressure, it blows backward nearly as strongly on the farther side from within the hollows of the moving blades just passed, and thus produces the reaction effect, after which it passes through the next row of stationary blades and, altering its path due to their curved inner faces, impinges against and imparts energy to the next row of moving blades. This action may be most readily understood by reference to Fig. 3, in which the path of the steam is traced through the fixed and moving blades by the arrows. From this it may be seen that the steam, in thus impinging against and receding from the moving blades, operates in the dual capacity of both the impulse and the reaction effects, and, also, that the stationary blades serve as nothing more than deflectors to change the direction of the flow of steam coming from one row of the moving blades and direct it toward the next row of moving blades.

Steam enters the turbine through the governor valve, arriving at chamber *A*, Fig. 2, and from there passes to the right through the series of stationary and moving blades, until it finally reaches chamber *B*. The areas of the passages between the blades increase progressively from the initial end toward the exhaust end, to correspond with the increasing volume of the steam as it constantly expands in doing work while passing through. The diameter of the turbine shaft is increased at *E* and again at *G*, and renewed progressions of turbine blades are placed upon these larger diameters, each of which by virtue of the greater peripheral velocities of the blades at the greater diameter, allows for the increased velocity of the steam. In this way the steam does its work by expanding progressively and continuously as it passes, although it is applied differently than in the piston engine.

In order to reduce the thrust that would occur from the endwise pressure of the steam as it is passing toward the exhaust, equalizing pistons and passages are provided to neutralize the end pressure in the direction taken by the steam, by means of counteracting pressure in the opposite direction. Thus, at *E* and *G*, Fig. 2, passages are provided to allow the pressures acting on the shoulders on the shaft to come against the equalizing pistons, C_1 and C_2, which are of equal sizes with the shoulders at *E* and *G*, respectively. At *K*, an equalizing passage is provided to neutralize the effect of either back pressure or vacuum in the exhaust. Then, in order to take care of any small amount of end thrust not entirely compensated for by these means, a thrust bearing is placed upon the shaft beyond the bearing, as at *H*, Fig. 2. This thrust bearing is adjustable endwise, in order that the shaft may be adjusted so as to bring the moving and stationary blades in proper relation to each other. The equalizing pistons, C_1 and C_2, do not touch the case, clearing it to prevent friction, but there is almost no leakage of steam past them at high speeds, due probably to the intense "air-washing" between their peripheries and the case when the turbine is at its normal speed.

The same tendency to temporary violent vibration at a "critical" speed is met in the Parsons turbine as in the De Laval turbine; but here it is provided for in a different manner by the peculiar construction of the bearings. The bearings are made of gun-metal sleeves, surrounded by several concentric, loosely-fitting sleeves, all of which are placed in the bearing pedestal and prevented from turning by a loose-fitting dowel pin. The spaces between the sleeves permit sufficient play to allow the shaft to run slightly eccentric if it is a trifle out of balance, thus accomplishing the same result as obtained by the long flexible shaft in the De Laval turbine.

The governing of the Westinghouse-Parsons turbine is accomplished, as in the outward flow turbine, by a steam relay governor, in which a fly-ball governor, in conjunction with a system of levers oscillated by an eccentric on the shaft, varies the duration of gusts of steam admitted to the turbine as required by the load. This method insures the admission of boiler pressure at all loads, in contrast to the throttling method of governing.

Another example of a turbine embracing both the impulse and reaction principles is the Dow series, or "compound" turbine. It is constructed on lines very similar to the outward-flow Parsons turbine, except that it has only two revolving discs instead of a series of them. It has steam passages through stationary guides and systems of vanes in alternation, the steam entering at the center and flowing, in general, radially outward, thus taking advantage of the enlarging areas of section to meet the requirements of the expanding steam.

One of the greatest difficulties that has presented itself in the development of the steam turbine has been the great speed at which it must run to utilize even a respectable fraction of the kinetic energy of the steam jet. Such high speeds are entailed that the turbine is at once limited in application unless very extensive reduction gearing be used. But the unavoidable inefficiency of mechanical gearings of all kinds suggested the possibility of an efficient transmission of the power of the turbine by electric current generated in a directly-connected high-speed dynamo, an application of which method to one of the first turbines resulted in complete success of operation. The dynamo used was a bipolar machine with a drum armature designed for very high speed, and proved to be well adapted to such conditions by running for a long time in an isolated plant, with perfect success and extremely low expense for repairs and maintenance. Later applications of the dynamo to different sizes and speeds of turbines have completely demonstrated the entire adaptability of the dynamo to turbine conditions, and the turbine-dynamo unit is now recognized as a rival of the piston engine as a converter of energy.

The future of the steam turbine is, however, a matter of some conjecture just at present. In spite of the fact that it has proved a success and is meeting with much favor abroad, it has not been entirely satisfactory in the United States. The development of the turbine in Europe has been phenomenally successful. One of the first Parsons turbines, built in England about 1884, ran for a long time driving a 30-kw. dynamo on board a steamboat with perfect success, requiring at a speed of 10,000 r.p.m. a steam supply of 35 lbs. per hour per electrical horse-power. The large turbo-alternators at the works of the Cambridge Electric Supply Company have run successfully for several years with very little expense for repairs and maintenance. Tests were recently made upon these turbines to ascertain if any deterioration had taken place while they were in use, with the result that no deterioration through wear was detected. The figures which were obtained regarding the steam consumption per horse-power-hour indicate that a steam turbine will, when working under the conditions of every-day service, retain its initial high efficiency. The recent installation of a Parsons turbine in the central station of Elberfeld, Germany, to drive a 1000-kw. three-phase alternator, furnishes further evidence as to the possibilities of this prime mover; tests made upon it with an average steam pressure of 162 lbs. and 14° of superheat showed a steam consumption per kilowatt-hour as low as 19.3 lbs. Thus the turbine seems to be meeting with marked success abroad.

The Westinghouse-Parsons turbine is the only one that has met with any success so far in this country. Three 500-h.p. turbines of this make have been in use at the power plant of the Westinghouse Air Brake Company for some time, driving 300-kw. two-phase bipolar alternators at 3600 r.p.m., and under test with a steam pressure of 125 pounds, gauge, and a 28-in. vacuum, have shown a full-load steam consumption of 16.4 lbs. per electrical horse-power-hour. A Westinghouse-Parsons direct-connected 1000-h.p. turbo-alternator installed in the electric light station at Hartford, Conn., last spring is being watched with a great deal of interest for results. It has not as yet operated to the complete satisfaction of the builders, but it is altogether probable that with a little experimenting the present difficulties will be removed.

The turbine has several points of advantage over the reciprocating engine which are alone sufficient to render it desirable in many cases, even if its efficiency were greatly less than that of the reciprocating engine. Among these advantages are its extremely low weight per horse-power; its small frictional resistance when in operation; its absolute regularity of speed, and the simplicity of its fittings. The inherently very high speed of the turbine, besides reducing the weight per horse-power of its own output, reduces also the size of electric generator per kilowatt capacity in like proportion, when direct connected, owing to the fact that the output of a dynamo is directly proportional to its speed. In the large dynamos direct connected to slow-speed reciprocating engines, which type has become so prevalent, a difficulty is introduced owing to the unavoidable variation of angular velocity of the armature due to the angularity of the connecting-rod of the engine; but this, in the turbine, is obviated by the absolute uniformity of its rotation. Moreover, the freedom from vibration due to the turbine's shaft assuming its gravitational axis when up to speed is an advantage that will render it very valuable in very many places where quietness of running is desirable. Again, its lower first cost and lower expense for maintenance as compared with the reciprocating engine assure it of a speedy adoption when finally perfected and freed from the mechanical difficulties that now prevent it from being adapted for general service.

A PRACTICAL DEMONSTRATION IN BOILER ECONOMY.

BY C. WATSON.

Much has been written and said regarding the losses that may occur in steam boilers from improper care, bad or dirty condition, etc., but nothing can make the facts so forcibly apparent as parallel tests made in such a way under good and bad conditions as to show up the difference. The real difference that may be made by the cooling off of a boiler, as well as the impairment of its furnace draft, caused by cracks in its setting, was very clearly shown recently in an actual trial of such a case.

A 60-in. by 16-ft. horizontal return-tubular boiler had been running about three years in an isolated plant supplying power and light to a factory, and during that time several small cracks had appeared in the brick setting. They had undoubtedly formed through settling of the foundations of the setting, and, although they were fairly noticeable, still they were not large. The engineer of the plant several times made requisitions for the necessary supplies with which to chink up these cracks, if not point up the entire setting, but he was refused the request by the manager in charge upon the ground that a few cracks in the setting would not make more than a few cents worth of difference in the expense at the most, and no argument could convince him to the contrary.

Finally, however, the case came to the notice of a steam expert, who, after asking the engineer the cause of the continued existence of the cracks, at once urged upon the manager the necessity of having all such hindrances to the draft of the furnace removed, if anything like economy was to be expected from the boiler in the use of coal. He ventured the opinion that there was a considerable waste of coal going on in the making of steam under such conditions, which was, as before, doubted by the manager. The dispute finally resolved into a wager as to who was right. Was the furnace wasting coal under those conditions, or not?

It was decided to make a test as carefully as possible of the coal consumption of the boiler in its present condition, and another test after having the setting refinished and repointed. Accordingly arrangements were made to keep a careful record of the amount of coal burned and also to record the conditions under which the boiler was being operated, in order that they might be duplicated; or at least any differences allowed for in the later test after the repairs had been made. A set of platform scales was provided by which to weigh the coal, and thermometers to determine the temperature of the feed-water were put in. The preliminary test was carried on for one week with the boiler in its original condition, the coal being weighed and the feed-water temperatures recorded. All other conditions were kept as nearly as possible constant, the level of the water in the boiler being kept at the middle gauge cock, and the damper in the chimney being kept in one position throughout. Hourly readings were taken from the ammeter and voltmeter of the dynamo in order to determine approximately the power being delivered by the engine.

On the Sunday following at the end of the first week the boiler was allowed to cool off, and then the necessary repairs were made to the brickwork of the setting. The cracks were all carefully chinked up and the cleaning door in the rear wall was entirely reset, it being found that the movement of the settling had shoved it bodily inward. After the work had been completed a test with a lighted candle in the usual way for further cracks indicated that all leaks had been closed. Then during the following week the record run was continued, exactly the same records being kept as before. The comparison proved to be very easy, as the loads were found to be practically identical on the engine throughout each day of both weeks, and the feed-water temperature varied scarcely any, which was to be expected, as it was taken from a well, no heater being used.

The result of the comparison of the records showed that the average power in watts delivered throughout each week by the dynamo varied but a trifle, being slightly greater for the second week than for the first; that the temperature of the feed water had not varied enough to merit attention, but that the coal burned during the second week was nearly three tons less than during the first week. This meant that with the boiler setting in its faulty condition it had been wasting between two and three tons of coal a week, and even more, really, if due notice be taken of the slightly greater load that was carried during the second week. At the prevailing price of the grade of coal used the saving of coal represented a value of something over $10, and thus with these repairs having been made the boiler was proven capable of generating the requisite amount of steam at a reduction in cost of over $40 per month, a very respectable saving. These revelations convinced the manager.

This instance is an object lesson which brings out more forcibly than is possible in any other way the absolute necessity of paying particular attention to small details in boiler management if economy is desired.

Lessons in Practical Electricity

RESISTANCE OF SIMPLE AND COMPLEX CIRCUITS.

While the term "conductor" is used in a general sense to define a material, of any shape, through which electricity readily flows, it is applied specifically to metallic strips and wires used to "conduct" the current from one point to another. A system of conductors connecting electrical devices with each other is called a "line," whether there be a single conductor or a group of them; the complete electrical path is termed a "circuit." Fig. 1 illustrates these definitions; a source, *E*, of electromotive force, is connected by a "line" of two conductors or wires, *W*, *W*, with an electrical device, *A*. The entire path of the current, including the source, *E*, is a circuit; that part outside of the source of current is called the external circuit, but the qualifying word "external" is omitted in general parlance, being used only when a definite distinction is necessary.

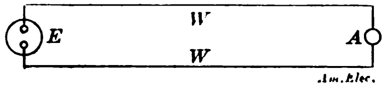


FIG. 1.—SIMPLE CIRCUIT.

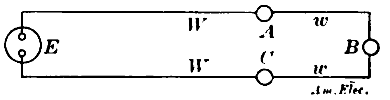


FIG. 2 - SERIES CIRCUIT

The circuit shown in Fig. 1 is the simplest form; Fig. 2 is a circuit of the "series" type. A "series" circuit is one in which the total current flows through every member of the circuit, which would be the case in Fig. 2. In such a circuit, the devices, *A*, *B*, *C*, are said to be connected "in series." Fig. 3 shows a different arrangement, known as a "multiple" or "parallel" circuit; here, the electrical devices are connected "in multiple" or "in parallel." A multiple or parallel circuit is one in which every device is so connected as to receive approximately the same e.m.f. or voltage. Electrical devices are sometimes connected into still more complex groups. Fig. 4 represents what is known as a series-multiple group and Fig. 5 is a multiple series group; the latter combination is more frequently found in practice. The terms used to describe these forms of circuit are shortenings of the literally descriptive definitions; Fig. 4 is a "series" of "multiple" groups, and Fig. 5 is a "multiple" of "series" groups, or several series groups connected in multiple.

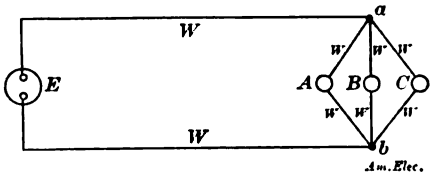


FIG. 3.—MULTIPLE CIRCUIT.

The current that will flow in any circuit is, according to Ohm's law, equal to the e.m.f. divided by the resistance of the circuit. In applying this law, the total resistance of the circuit must be the value used. The total resistance of a series circuit is equal to the sum of the resistances of all the individual members or sections of the circuit. Thus, in Fig. 2, the total circuit resistance is equal to the sum of the resistances of the source of current, *E*, the wires, *W*, the devices, *A*, *B* and *C*, and the intermediate wires, *w*. Example: If the internal resistance of *E* is 1/3 ohm; the resistance of each wire, *W*, ½ ohm; the resistance of each device, *A*, *B* and *C*, 6 ohms, and that of each wire, *w*, 1/3 ohm, the total resistance through which the e.m.f. of *E* must force current will be 1/3 + ½ + 6 + 1/3 + 6 + 1/3 + 6 + ½ = 20 ohms. Consequently, if the e.m.f. of *E* is 60 volts, the current flowing in the circuit will be 3 amperes.

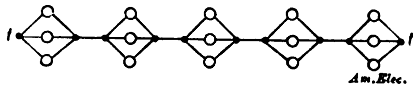


FIG. 4.—SERIES-MULTIPLE CIRCUIT.

The resistance of a multiple circuit is not quite so readily computed; the joint resistance of the branches in multiple is equal to the reciprocal of the sum of the reciprocals of the individual resistances*. In dealing with multiple circuits, however, it is generally more convenient to think

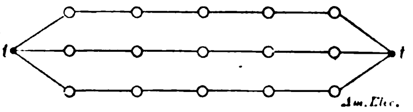


FIG. 5.—MULTIPLE-SERIES CIRCUIT.

---

*Let R_1, R_2, R_3, R_4, etc., represent respectively the individual resistances of the branches; then the joint resistance of the group will be

$$R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} \text{ etc.}}$$

of the conductance of the circuit instead of its resistance, conductance being the reciprocal of resistance. The joint conductance of several branches in multiple is equal to the sum of the conductances of the individual branches. Unfortunately, there is no unit of conductance[†], so that it must be expressed as inverted resistance. For example, if each device, *A*, *B* and *C*, in Fig. 3, with its individual wires, *w*, has a resistance of 6 ohms, the conductance of each branch will be 1/6; the sum of the three conductances, 1/6 + 1/6 + 1/6, is ½, and the joint resistance of the group will be the reciprocal of ½, or 2 ohms. As the group is in series with the remainder of the circuit, its resistance must be added to that of the wires, *W*, *W*, and the source, *E*, in order to ascertain the total resistance. If the resistance of the source, *E*, were 1/3 ohm, and that of each wire, *W*, were the same, the total resistance of the circuit would be 3 ohms, and an e.m.f. at *E* of 60 volts would cause a current of 20 amperes to flow. This whole current would pass through the source, *E*, and the wires, *W*, *W*, but at the junctions, *a* and *b*, it would divide, part passing through each branch, *w*, *A*, *w*; *w*, *B*, *w*, and *w*, *C*, *w*. As the resistances of the three branches are equal, the current will divide into three equal parts, 6 2/3 amperes going through each branch.

But it frequently happens that the branches of a multiple circuit have different resistances, in which case the sections or members of the circuit must be considered separately and Ohm's law applied to them individually. If the resistance of *A* and its connecting wires, *w*, *w*, be 10 ohms, that of *B* and its wires 15 ohms, and that of *C* and its wires 30 ohms, the individual conductances will be 1/10, 1/15 and 1/30; the conductance of the group is the sum of these, or 1/5, and the resistance of the group is the reciprocal of this, or 5 ohms. Add this to the resistance of the wires, *W* (1/3 ohm each), and that of the source, *E* (1/3 ohm), and the total is 6 ohms. The e.m.f. at *E* being 60 volts, the current will be 10 amperes. Now, out of the total e.m.f., 10 volts are required to force the current through the resistance of the line wires, *W*, and the source of current[‡], so that the e.m.f. available for forcing current through the group, *A*, *B*, *C*, will be 50 volts. The resistance of *w*, *A*, *w* being 10 ohms, the current in this branch will be 50 ÷ 10 = 5 amperes; the resistance of *w*, *B*, *w* being 15 ohms, the current will be 50 ÷ 15 = 3 1/3 amperes; *w*, *C*, *w* is of 30 ohms resistance, so that its current will be 50 ÷ 30 = 1 2/3 amperes. The sum of the currents in the three branches is obviously 10 amperes, the same as in the line wires

Considering now the more complex circuits, the total resistance of the path between *t* and *t* in Fig. 4 is the sum of the resistances of the individual groups, and the resistance of a group is equal to the reciprocal of its conductance; the conductance of a group is equal to the sum of the conductances of the three devices. Thus, if the resistance of each single device and its short connecting wires were 6 ohms, the conductance would be 0.1667; the conductance of a single group, therefore, would be 3 × .1667 = 0.5, and its resistance would be $\frac{1}{0.5} = 2$ ohms. There being five groups in series between *t* and *t*, the total resistance would be 10 ohms. The case of Fig. 5 is similar. If each device is of 6 ohms resistance, each series group of five will have a resistance of 30 ohms. The conductance of each group will be 0.0333 and the total conductance 0.1; the total resistance, therefore, will be 10 ohms, as in Fig. 4.

The general rules for all circuits may be expressed thus:

I.—The total resistance of members in series is equal to the sum of their separate resistances.

II.—The total conductance of members in multiple is equal to the sum of their separate conductances. [The conductance of any electrical path is the reciprocal of its resistance (1 ÷ Resistance)].

Letters on Practical Subjects

Improved Permanent-Magnet Measuring Instruments.

To the Editor, American Electrician;

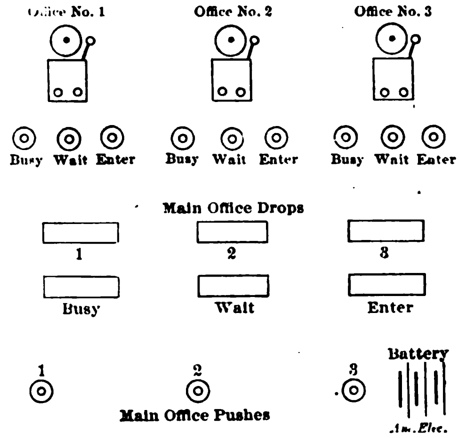
Sir:—On page 394 of the American Electrician for August, 1901, I have noticed a paragraph headed "Measuring Instruments having Magnets;" being an abstract from a recent article by Mr. P. Weiss, published in the "Comptes Rendus." The principle described by Mr. Weiss, which forms the subject of your abstract, is relatively old in the American art, and a commercial instrument embodying this principle has been manufactured and sold in the United States for a long time by the General Electric Company. I call attention to the matter because I dislike the thought that credit for so important and valuable an improvement in electrical measuring instruments should be accorded exclusively to a European source.

New York. Caryl D. Haskins

A Problem in Bell Wiring.

To the Editor, American Electrician;

Sir:—The accompanying diagram represents the bells, annunciators, drops, and push buttons of a main office and three private offices, for the operation of which a single battery in the main office is employed. The main office is provided with a six-drop annunciator, the drops being marked 1, 2, 3, "Busy," "Wait," "Enter." There are three push buttons in the main office for the purpose of calling up the individual private offices, and in each private office there is a bell responding to the main office push button, and three push buttons, each of which throws two of the annunciator drops in the main office. All of the push buttons in office No. 1 throw drop No. 1 in the main office; similarly, all of the push buttons in office No. 2 throw drop No. 2 in the main office, and all of those in No. 3 throw drop No. 3. Each of the individual push buttons, in addition to throwing the drop corresponding with the number of its office, also throws one of the lower drops, the legend of which corresponds with the legend over the push button. For example, the extreme left-hand push button in office No. 1 must throw drop No. 1 and the drop marked "busy" in the main office, and so on throughout the three offices. It will probably interest some of your readers to supply the wiring connections necessary to obtain these results from a single battery and with the use of ordinary push buttons. A. Schuhmann.



PROBLEM IN BELL WIRING.

San Francisco, Cal.

[Mr. Schuhmann has placed on file with us the solution of the above problem.—Editor.]

Laying Out Interior Wiring.

To the Editor, American Electrician;

Sir:—In most jobs of interior wiring for incandescent service, barring, of course, installations of such magnitude as to be removed from the general class, and therefore requiring special consideration, it will be found practical and most advantageous to resolve the system into one comprising two elements, so far as computation is concerned—namely, feeders and mains. The reduction of the number of significant elements to two involves making all elements except these two negligible as to their effect upon the candle-power of the lamps. For example, if an installation is of such a character as to necessitate the use of feeders, subfeeders, mains and taps, then two of these four classes of members must have negligible drop; it will usually be found entirely feasible to so proportion subfeeders and taps that the drop in them will be so small that it may be ignored, leaving only the feeders and mains to be calculated.

[†] Some years ago, it was suggested to use Ohm's name, spelled backward, as the unit of conductance, thus, "mho." This monstrosity came into limited use, but has never been authoritatively adopted. In view of the pioneer work by Edison in rendering practical the industrial utilization of multiple circuits, it has been suggested that conductance be expressed in edisons. The name of Stephen Gray, the discoverer of electrical conductance, has also been suggested.

[‡] $\text{Amp.} = \frac{\text{Volts}}{\text{Ohms}}$; hence, Volts = Amp. × Ohms

Thus, a variation of ¼ volt in the drop on a 110-volt system is practically negligible—in fact, it is seldom that the actual drop at any point of a 110-volt circuit comes within ¼ volt of the calculated drop, on account of variations in load and discrepancies between the calculated and the actual length of circuit wires. Table I., herewith, gives distances to which the standard sizes of wire will carry different numbers of lamps at negligible drop (¼ volt for a 110-volt system, and ½ volt total for a 220-volt system). The table shows that the size of wire required for "negligible-drop" taps and sub-feeders of ordinary length is not much larger than the limiting size specified by the National Code. This procedure has not only the advantage of reducing the number of elements to be calculated, but the additional advantage of a nearer approximation to uniform voltage at the lamps.

Geo. W. Malcolm.

Brooklyn, N. Y.

TABLE I.—GIVING CAPACITIES OF LINE WIRES AT NEGLIGIBLE DROP.

3½ watt lamps.		Wire Sizes; B. & S. Gauge: No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 12	No. 14
110 v.	220 v.	Distance in Feet:								
1	4	968	768	608	482	382	303	240	151	95
1½	6	645	511	405	321	255	202	160	101	63
2	8	482	383	303	240	191	151	120	75	47
2½	10	387	307	243	193	153	121	96	60	38
3	12	322	255	202	160	127	101	80	50	32
3½	14	276	219	173	137	109	86	69	43	27
4	16	242	192	152	120	95	76	60	38	23
4½	18	215	170	135	107	85	67	53	33	21
5	20	193	153	122	96	76	60	48	30	19
5½	22	176	139	110	87	69	55	44	27	17
6	24	161	128	101	80	64	50	40	25	16
6½	26	149	118	93	74	59	47	37	23	14
7	28	138	109	87	69	54	43	34	21	13
7½	30	129	102	81	64	51	40	32	20	12½
8	32	121	96	76	60	48	38	30	19	12
8½	34	114	90	71	57	45	35	28	18	11
9	36	107	85	67	53	42	33	26	17	10½
9½	38	102	81	64	51	40	32	25	16	10
10	40	97	77	61	48	38	30	24	15	9½
10½	42	92	73	58	46	36	29	23	14¼	9
11	44	88	70	55	44	35	27	22	13½	8⅔
11½	46	84	66	53	42	33	26	21	13	8⅓
12	48	80	64	50	40	32	25	20	12½	8
12½	50	77	61	48	38	30	24	19	12	7⅔
13	52	74	59	47	37	29	23	18½	11½	7⅓
13½	54	71	57	45	35	28	22	18	11	7
14	56	69	55	43	34	27	21½	17	10⅔	6¾
14½	58	66	53	42	33	26	21	16½	10⅓	6½
15	60	64	51	40	32	25	20	16	10	6¼
15½	62	62	49	39	31	24½	19½	15½	9½	6
16	64	60	48	38	30	24	19	15	9	5¾
17	68	57	45	36	28	22	18	14	9	5½
18	72	53	42	33	27	21	16½	13	8½	5¼
19	76	50	40	32	25	20	16	12½	8	5
20	80	48	38	30	24	19	15	12	7½	.....
21	84	46	36	29	23	18	14½	11½	7	.....
22	88	44	35	27	22	17½	13½	10⅔	6¾	.....
23	92	42	33	26	21	16½	13	10⅓	6½	.....
24	96	40	32	25	20	16	12½	10	6¼	.....
25	100	38	30	24	19	15	12	9½	6	.....

The application of the table to 220 volts is intended for the three-wire system, with 110-volt lamps, although it would apply to a 220-volt two-wire system if 3½-watt high-voltage lamps were obtainable.

The fractional numbers of lamps are to provide for 24-c.p. units.

◆

The Inoculation Theory Enlarged.—An employee of the electric lighting company in a Wisconsin city having recovered after receiving a severe shock from the switchboard (by contact with a 5500-volt circuit, it was claimed), the attending physician said that the only reason he could ascribe for the man's fortunate escape from death was that "men working around the house in an atmosphere of electricity become impregnated with it and therefore are not so liable to fatal injury as those who are not thus made immune."

Electrical Catechism

643. How is the polarization removed?

In some cells the gas bubbles rise to the surface and escape to the air, the surface of the negative plate being made rough, so as to offer many fine points where the gas may collect and escape. In other cases a "depolarizer" is provided to unite chemically with the gas, and form a substance that will dissolve in the liquid. For this purpose black oxide of manganese, oxide of copper, red lead, peroxide of lead, sulphur, bromine, chlorine, nitric acid and solutions of chromic acid, bichromate of soda, bichromate of potash, nitrate of potash and ferric chloride are used. Some of these attack zinc even when the circuit is not closed, and are used in cells for intermittent work on circuits that are generally open. Liquid depolarizers generally work rapidly, and the cell may be used continuously, with but little diminution of the e.m.f.

644. Explain the action of the sal ammoniac cell.

This cell has carbon and zinc electrodes, immersed in a solution of sal ammoniac (NH_4 Cl), technically known as ammonium chloride. The solution has no effect on either electrode when the circuit is open. But when the circuit is closed, the zinc is dissolved, and breaks up the sal ammoniac, forming zinc chloride ($ZnCl_2$), ammonia (NH_3), and hydrogen (H_2). The ammonia immediately dissolves in the water of the solution and forms ammonium hydroxide (NH_4OH), while the hydrogen collects on the carbon electrode. In many cells, such as the Law, Diamond and Laclede cells, the hydrogen simply collects on the carbon during the action of the cell, and then gradually rises to the surface, and escapes to the air while the cell is resting. The larger the surface of the carbon, the longer will the cell work without rest. Other forms of sal ammoniac cell have a chemical depolarizer, and are known by the general name Leclanché cell. Sal ammoniac cells gives from 1.3 to 1.7 volts when new.

645. Explain the action of the Leclanché cell?

In the Lelanché cell the carbon is placed in contact with some solid substance which will unite chemically with the hydrogen, and so remove the polarization. In the original Leclanché cell the carbon was placed in a porous cup, which was then filled with manganese dioxide (MnO_2), which readily gave up part of its oxygen to form water (H_2O) with the hydrogen, and became reduced to a lower oxide (Mn_2O_3). The manganese was mixed with fragments of carbon to increase the conductivity, and to hold more gas. The porous cup was found to increase the internal resistance of the cell, and the manganese dioxide was then mixed with carbon and cement to form blocks, which were then held against the carbon plate by means of rubber bands. The next step was to make the carbon in the form of a hollow cylinder, and place the depolarizer inside, as in the Samson and the Hayden cells. In some cells the depolarizer is mixed with the carbon, and both are molded and baked into a solid mass; such cells do excellent work at first, but are apt to wear out quicker than those in which the depolarizer can be renewed. Many millions of sal ammoniac cell are used for operating bells and telephones.

646. How strong should the solution be in a sal ammoniac cell?

The directions vary with different cells, but about five ounces of the dry salt to one quart of water is an average solution. If the solution is too strong, a double salt of the chlorides of zinc and ammonium is liable to crystallize out and deposit on the zinc, thus increasing the internal resistance of the cell and also lowering its e.m.f.

647. Why do the zincs in sal ammoniac cells usually eat through at the top faster than at the bottom?

There is generally more or less of the double chloride of zinc and ammonium present in every sal ammoniac cell. As this is heavier than the mixed solution of zinc chloride and of ammonium chloride, it settles toward the bottom of the cell. There is then a local action which tends to dissolve the zinc at the top and to deposit it at the bottom, for zinc in a solution of zinc chloride is positive to zinc in a solution of the double salt; the zinc and the liquid thus become a short-circuited cell.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

Why is the neutral of a three-wire system grounded? W. A. H.

This is fully explained on page 535 of our issue for November, 1900.

How far apart should the wires of a transmission pole line be placed to carry 10,000 to 20,000 volts? S. L. S.

Twenty-four inches.

How much resistance must I put in circuit with a 5-volt voltmeter in order to increase its range to 25 volts? F. K.

Four times the resistance that is now between the terminals of the voltmeter.

Give a simple rule for finding the current in each branch of a divided circuit, the three branches having different resistances. H. F. W.

Refer to the Lessons Department of this issue.

How are lead strips soldered to the terminals of storage batteries? E. L. K.

The strips are not soldered; they are fused together. The surfaces must be scraped thoroughly clean and fused by means of a hydrogen blow-pipe; an ordinary illuminating gas flame will not do.

What causes the humming emitted by alternating-current wattmeters? C. M. N.

The vibration of the thin sheets of iron forming the core of the magnet in the instrument. This vibration is due to the rapid alternations of magnetism, which in turn are caused by the alternations of the current. Alternating-current instruments not containing iron cores do not hum.

Is a 150-light dynamo usually provided with a voltmeter and an ammeter? (2). Which instrument is more necessary? (3). Does a 400-lamp circuit (110 volts and 16 candle-power) require a 200-ampere switch? J. G.

Yes. (2) The voltmeter is more necessary, but both should invariably be used. (3) If the lamps take 3.1 watts per candle this switch will suffice. If they are of lower efficiency than this a 250-ampere switch must be used.

In charging storage batteries which terminal of the battery should be connected with the positive line wire? (2). What is the best solution for a carbon and zinc battery? A. R. T.

The positive terminal. (2) Electropoion, made as follows: Mix one quart of concentrated sulphuric acid with three quarts of water. In a separate vessel dissolve 1½ lbs. of bichromate of potash in half a gallon of boiling water; then mix the two fluids.

Can two transformers be connected up delta fashion on a three-phase system? C. J. S.

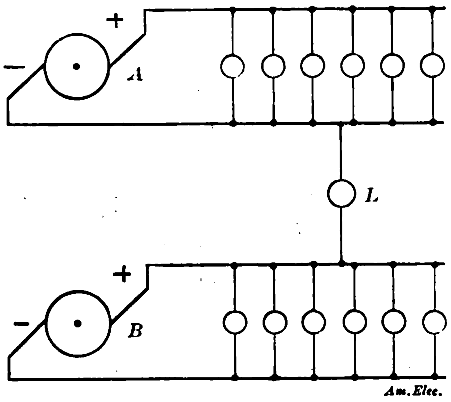
A complete "delta" cannot be formed with two transformers, for the reason that "delta" is a triangle, and therefore there must be three conducting paths. Two transformers can be connected to form two of the sides of a delta connection on the three-phase system; in this case each transformer must carry 1.73 times the load that each one would carry if there were three transformers.

How is a dynamo compounded? (2). What is meant by over-compounding? J. D.

By providing the field magnet with a series winding through which most of the main current flows, and which adds to the excitation supplied by the shunt winding. (2). An over-compounded dynamo is one having series coils sufficiently powerful to raise the full load e.m.f. at the brushes to a value higher than the e.m.f. at no load.

If two lighting systems are connected together through a lamp, as indicated at *L* in the diagram, what would be the effect? W. T. A. F.

If both systems were thoroughly insulated otherwise, there would be no effect.



If the positive sides or the negative sides of both systems were solidly grounded, then the lamp would burn at full candle-power. If the positive of the system *A* and the negative of the system *B* were solidly grounded the lamp would be subjected to double voltage and burn out.

Is it good practice to run a 200-kw. alternator in parallel with a 60-kw. machine, both giving three-phase currents at 60 cycles? C. N. B.

There is no serious objection to doing so, but it would be better practice if the machines were nearer equal size.

What is the formula for rewinding a dynamo or motor to run at a different speed, the voltage remaining the same? F. R. A.

$$\frac{\text{Present speed} \times \text{Nw}}{\text{Desired speed}} = \text{new Nw.}$$

Nw represents the total number of wires around the armature circumference.

Do molding and iron conduit work come under the head of exposed or concealed wiring? A. C.

Interior wiring is no longer divided into two classes of "exposed" and "concealed" work, as formerly. There are now four classes: open work, where the wire is in sight and supported by knobs or cleats; moulding work, in which the wire is carried in moulding; conduit work, the name of which is self-explanatory; and concealed knob and tube work, which means wires supported on knobs and tubes between walls and under floors.

Why does the speed of a motor increase or decrease when the brushes are shifted away from the normal commutating point? H. G.

Shifting the brushes alters the counter e.m.f. of the armature; if they are in the position where the counter e.m.f. is maximum and are shifted either forward or backward from that position some of the armature coils will oppose an equal number on the other side of the neutral plane and reduce the counter e.m.f. of the armature. The speed will therefore increase until the counter e.m.f. is brought up to the normal point.

What is the ratio between the exciting current and voltage required by the field of an alternator and the current delivered from its armature? W. B. B.

There is no definite ratio. The field magnets of all alternators, except very large machines, are excited by 125-volt dynamos, because this is a standard voltage and an ordinary lighting dynamo can be used as an exciter. The exciting current required depends upon the efficiency of the alternator. It is quite possible to find two machines of widely different output requiring exactly the same exciting current.

Some Engineers' Handbooks state that a boiler will supply an engine of three times its own horse-power, and others give different ratios; what is the correct ratio between boiler and engine horse-power? J. W. M.

There is no fixed ratio between boiler and engine horse-power. One engine may require two or three times as much steam per horse-power as another, in which case a given boiler would take care of two or three times as many efficient engines as it would of the inefficient type. For example, a boiler evaporating 3000 lbs. of water per hour will supply an engine of 100 horse-power requiring 30 lbs. of water per hour per horse-power. The same boiler would supply a 200-h.p. compound condensing engine requiring 15 lbs. of water per hour per horse-power.

How can the pull on the armature wires of a dynamo or motor be calculated? A. A. R.

If the magnetic flux under one pole-piece be represented by Φ, the number of wires around the armature circumference by *Nw*, the average diameter of the armature from center to center of opposite groups of wires by *d*, and the total armature current by *C*, the pull in pounds will be given by the formula:

$$\frac{\Phi \, \text{Nw} \, \text{C}}{35{,}508{,}000 \times \text{d}} = \text{Pull.}$$

Another formula which will usually be found more convenient, is the following:

$$\frac{\text{E C} + \text{C}^2\text{R}}{0.355 \times \text{d} \times \text{r.p.s.}} = \text{Pull.}$$

In this formula *E* is the e.m.f. measured at the brushes, *R* is the resistance of the armature circuit from brush to brush, and *r.p.s.* is revolutions per second. If applied to motors, the numerator would be $E\,C - C^2 R$. For machines with two-path armatures the numerators of both formulas must be multiplied by one-half the number of poles on the machine.

SELECTIVE SIGNALING SYSTEM FOR TELEPHONE PARTY LINES.

One of the most attractive problems in the telephonic field has been the provision of a simple selective system of signaling whereby any predetermined subscriber on a party line might be called up without disturbing other subscribers on the same line. Various solutions of this problem have been devised, ranging in complexity from the harmonic system down, one of the simpler methods being that of the Metropolitan Telephone & Electric Company, Chicago. This system is illustrated diagrammatically by Fig. 1 herewith. It consists broadly of differentially-wound call bells with winding circuits of differing reactive characteristics, and two sources of signaling current of differing frequencies.

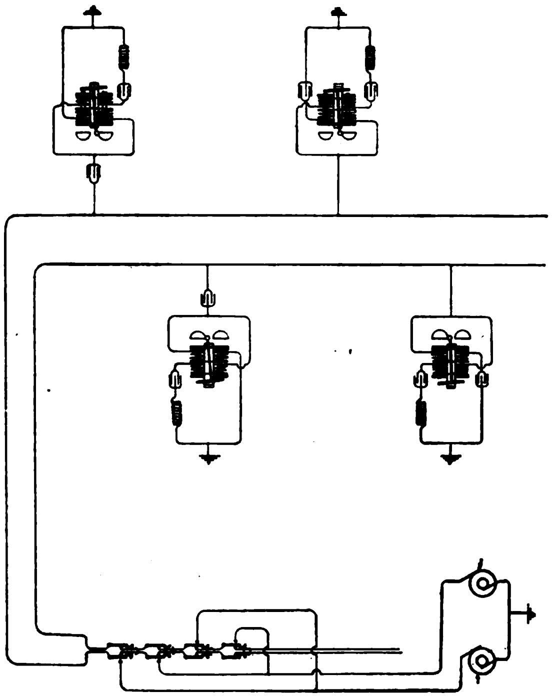


FIG. 1.—DIAGRAM OF CONNECTIONS.

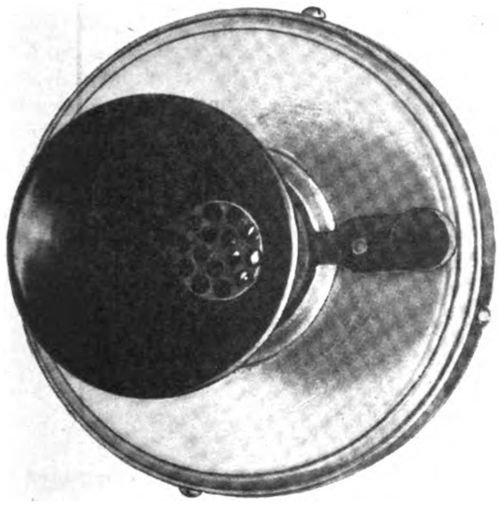


FIG. 2. -TRANSMITTER.

Referring to the diagram, it will be seen that two of the bells are connected between one side of the metallic talking line and the ground, and the other two between the other side of the line and the ground, the arrangement of one pair being exactly like that of the other pair. The leads of the two generators (one of 16 cycles and the other of 26 cycles frequency) go to jacks by means of which either generator may be connected between either line-wire and the ground. Referring now to the upper pair of call bells connected to the same line-wire, it will be noted that the line is not connected solidly to the ground through either one. It goes to the left-hand bell through a condenser, dividing beyond the condenser and passing to ground through the two differential windings in parallel. In series with one of these windings are a condenser and a reactive coil, so proportioned that when a current of 26 cycles passes, the capacity and inductance neutralize each other, and the current divides equally between the windings. Consequently when the 26-cycle generator is connected to this line-wire the first bell does not ring; but current from the 16-cycle generator will meet with greater impedance in the composite branch of the divided circuit of this bell than in the other branch, and there will be an unequal division of current in the two branches, causing the bell to ring. The divided circuit of the second bell (on the right of the diagram) contains a condenser in one branch and both a condenser and a reactive coil in the other. These are so proportioned that the impedance of the two branches are equal when the 16-cycle current passes through; consequently, this current will divide equally between the branches and the bell will remain silent. At 26 cycles, however, the impedance of one branch will be greater than that of the other, and the current will divide unequally; the preponderance of current in the branch of lower impedance causes the bell to ring.

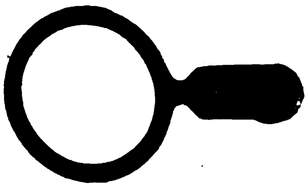


FIG. 3.—DAMPING DEVICE.

The circuits of the other pair of call bells being precisely like those just described, it is evident that either of the left-hand or nearer bells may be rung by plugging the 16-cycle generator to the line-wire to which the bell is connected, and that either of the right-hand or farther bells will respond when the 26-cycle generator is plugged to its line-wire. It will be obvious that two distinct generators must be employed, as currents of both frequencies are likely to be required simultaneously for different party lines. The simplicity of the bell winding, however, more than compensates for this; moreover, all the bells are exactly alike, and therefore interchangeable, which also tends to offset the extra expense for generators.

The Metropolitan Company's system includes another notable detail, illustrated by Figs. 2 and 3. This is a transmitter damping button, mounted directly on the front of the transmitter and designed to take the place of the push-button cut-out commonly employed. The large ring, shown in Fig. 2, is clamped under the transmitter mouth-piece, and the spring extension carries a finger button at the extreme end and a damping pin at an intermediate point. The pin projects from the under side of the extension piece through a hole in the transmitter case. When the finger button is depressed the pin comes into contact with the diaphragm and stops its vibrations, thus preventing interference with the receiver currents. Each damping device is adapted especially for the transmitter on which it is to work, in order to obtain an exact relation between the damping pin and the diaphragm.

◆

AUTOMATIC COAL-WEIGHING SCALES.

Many of the difficulties attending the construction of automatic weighing scales arise from the fact that weighing is essentially a delicate operation, and that in order to justify its own existence the machine, aside from positive action, must give fairly accurate results. Of the various causes which militate against such action, consider the impact of the material falling into the hopper, the force required to shut off the supply at the proper moment, the dumping of the hopper, its return to the receiving position, the dust which always accompanies the handling of material in bulk, and which clogs the mechanism, and the difficulties of the problem become apparent.

The Clarke automatic scale illustrated herewith is said to practically solve these difficulties. In essence, it consists of a supplemental weight raised by a counterpoise and hung on a hook, while the empty hopper is being returned to its receiving position. At the proper moment a tripping mechanism releases this hook, whereupon the supplemental weight is transferred to the hopper, the hopper dumps itself under the increased weight and operates the gate. This done, the counterpoise returns the supplemental weight to its raised position, where it is ready to again perform its functions. The scale is made in two forms; one of which is for continuous, and the other for intermittent operation. The former is used for weighing material while it is being placed in storage bins; the latter is used in weighing material as it is used. For example, a central power station would use the first form in filling its coal bunkers, and the second form in weighing out the coal to the boilers.

Fig. 1 shows a scale with its lower parts exposed. The charging hopper, *a*, is connected with the coal bunkers through a spout. Its lower end is provided with gates which are closed at appropriate times. Immediately below it is a weighing hopper, *b*, extending through the center of the machine and fitted with gates at its bottom, and a flaring top, *c*. Connected to *b* by means of chains running over concealed ball-bearing sheaves, is a counterpoise, *d*. At *e*, is one of the supplemental weights hung from the arm, *f*, which is connected by a cross shaft to a similar arm and weight on the other side of the machine. This arm is shown in two positions in Fig. 3, indicated by dotted and full lines. It carries a latch, *g*, shown in Figs. 2 and 3, which engages the stationary latch, *h*, and holds the supplemental weights suspended. After the load has been discharged, the counterpoise *d*, and its mate on the opposite side cause the hopper to rise quickly, carrying with it the supplemental weights, closing the gates at the bottom of the weighing hopper, and opening those at the bottom of the charging hopper. As the weighing hopper and the supplemental weights rise, the latch *g* passes the latch *h*; the weight however remaining suspended from the hopper.

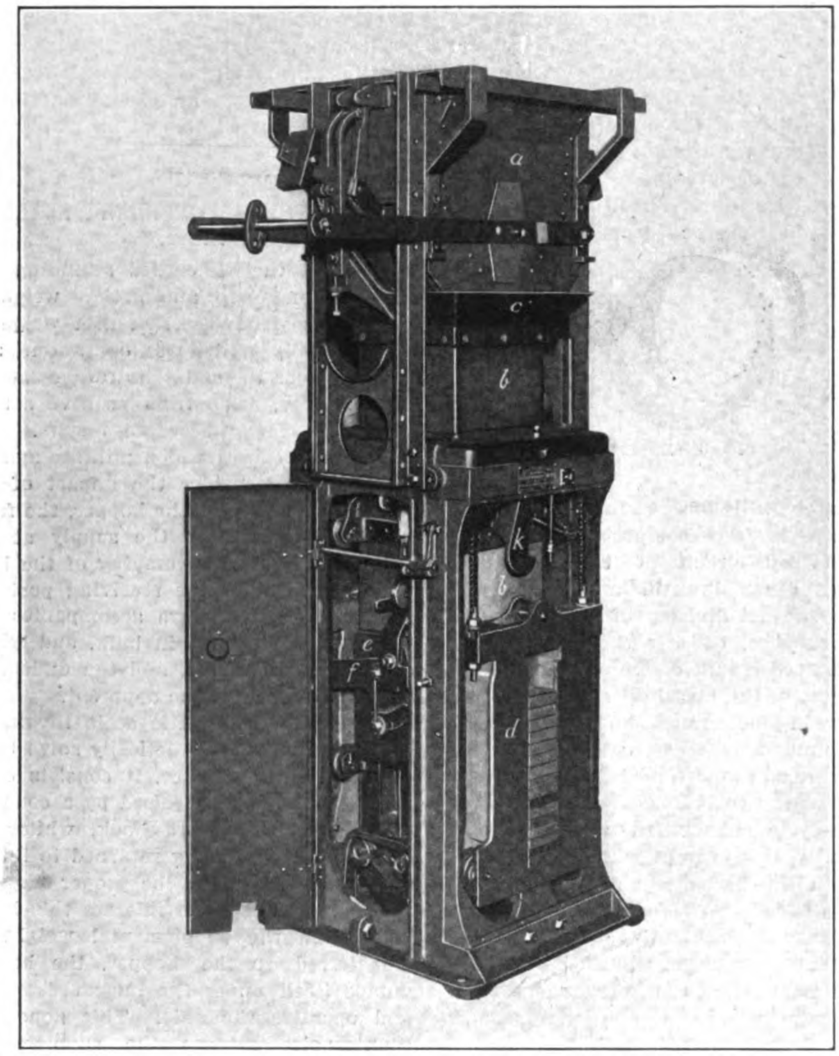


FIG. 1.—THE CLARKE AUTOMATIC SCALE.

When sufficient material has accumulated in the hopper, it descends a short distance until the latches *g* and *h* engage each other, when the movement is arrested. The supplemental weight being now hung up, the hopper is under the influence of the counterpoise weights only, and when full enough to overbalance them the hopper begins to drop, and the finger *i*, shown in its elevated position by dotted lines in Figs. 2 and 3, engages the roller *j* of the latch *h*, and presses it back. This releases the latch *g*, and the supplemantal weight is at once transferred from the latch to the hopper, which, under the influence of the added weight, drops and dumps itself by releasing a latch which allows a gate at its bottom to open. It also releases another latch and thus causes a weight to close the gate that controls the supply of material.

After the material is discharged there is, of course, a large surplus of power in the counterpoise weights which raise the empty bucket and the supplemental weight and close the lower and open the upper gates. To prevent the hopper from rising as soon as a portion of its contents is removed, a latch *k*, shown in Fig. 1, is provided, which, by engaging the pin below it in the counterpoise *d* as the latter rises, holds it in that position with the hopper down and the supply gate closed. To resume operations it is necessary to unhook this latch by pulling a cord supplied for that purpose. The connections between the cord and the latch, however, are such that the latch immediately springs back to its operative position after the cord has been pulled, and can only be unhooked again after the cord has been released. Where the material is delivered in a closed chute, the action may be made automatic, the passing of the charge down the chute being made to operate the latch.

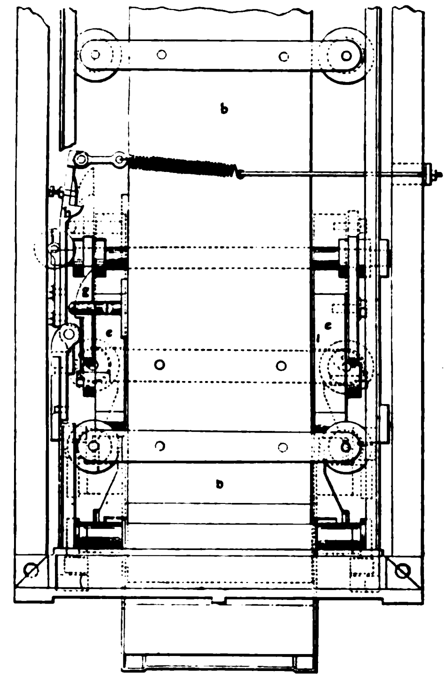


FIG. 2.—AUTOMATIC SCALE.

Tripping at the proper moment is provided for by making the weighing hopper adjustable in volume. The hopper has false sides which are so adjusted that at the moment of tripping the hopper is exactly full to the gates. The dumping of the load actuates a counting mechanism which records the number of loads dumped. This, multiplied by the weight of a hopper-full of material, gives the weight of the material handled during the time the machine was working. The scales are the product of the Clarke Automatic Scales Company, of New York.

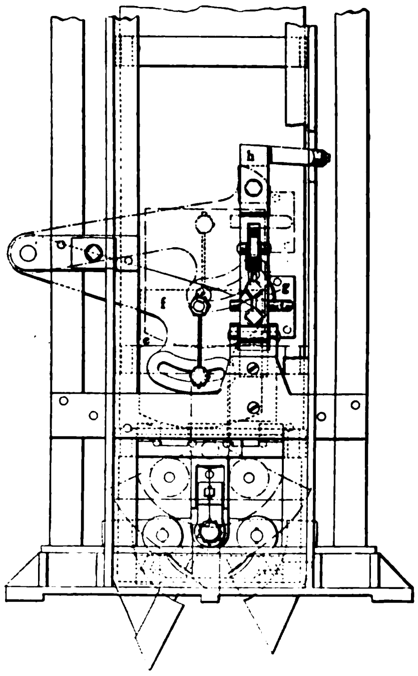


FIG. 3.—AUTOMATIC SCALE.

SYMMETRICAL DISTRIBUTION FROM INCANDESCENT LAMPS.

In a paper read by Mr. Francis W. Willcox before the National Electric Light Association at its last annual meeting, the distribution of light in vertical and horizontal planes from standard incandescent-lamp filaments was very clearly illustrated by means of polar diagrams. These diagrams show that the distribution from most of the commercial forms of lamp filament is unsymmetrical, the old-fashioned hair-pin or single-loop filament giving the nearest approximation to perfect distribution in a horizontal plane. The lack of symmetry in incandescent light distribution has, of course, been recognized for many years, and numerous forms of filament have been devised with a view to approximating more and more closely perfect symmetrical distribution. The accompanying diagrams, taken from those of Mr. Wilcox, show roughly the results of these efforts.

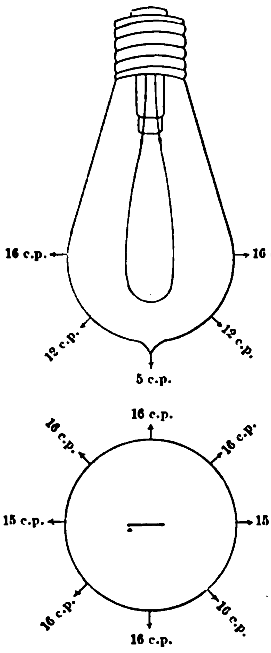


FIG. 1.

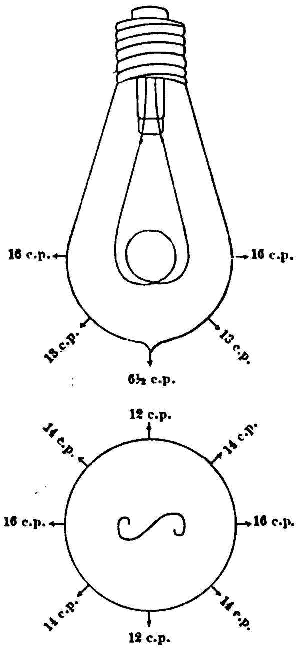


FIG. 2.

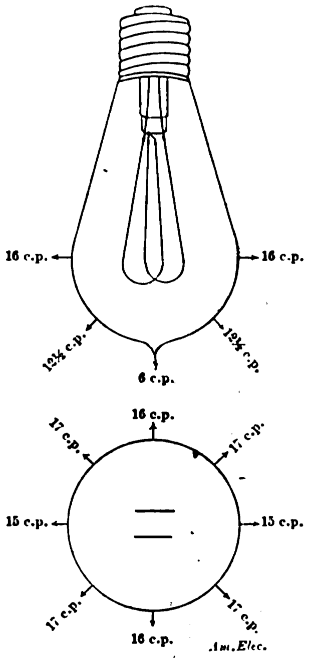


FIG. 3.

Fig. 1 shows the vertical and horizontal distribution at 45° intervals from the single-loop or hair-pin filament just referred to; it will be observed that the horizontal distribution is almost perfect, full candle-power being obtained in six out of eight radial directions about the axis of the lamp. The vertical distribution, however, shows a small percentage of maximum candle-power measured straight downward through the tip of the lamp. Fig. 2 is the single-coil filament, which was the next development. This form gives a slightly better distribution in a vertical plane, the candle-power downward through the tip being 6½, and at 45° 13 candle-power. The horizontal distribution is more irregular than that from the single loop, ranging from 12 candle-power to maximum.

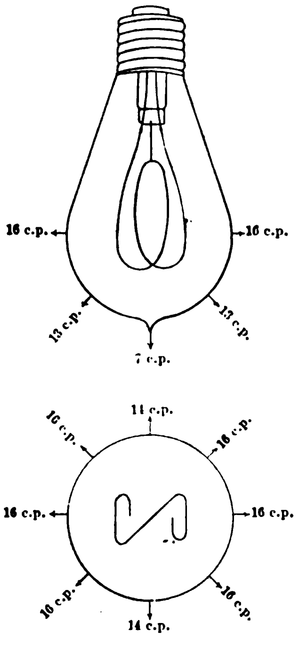


FIG. 4.

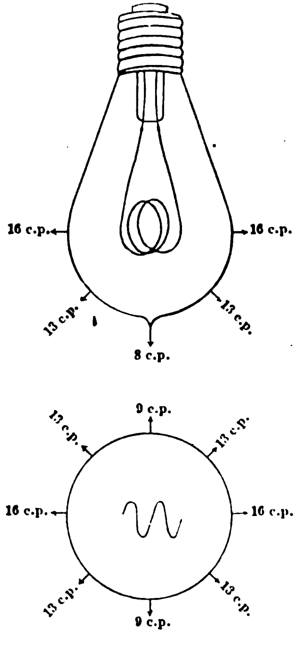


FIG. 5.

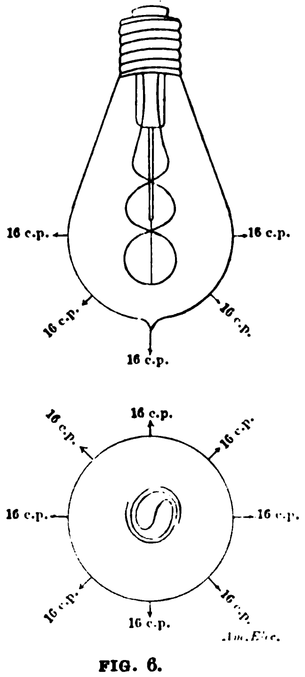


FIG. 6.

The double-loop or twin-filament lamp, indicated in Fig. 3, gives approximately the same vertical distribution but considerably better horizontal distribution than the single-coil filament, the horizontal distribution ranging from 15 to 17 candle-power in a 16-c.p. lamp. The oval-anchored filament, Fig. 4, gives further improvement in the vertical plane, the candle-power through the tip being 7, and that at 45° being 13. The horizontal distribution is also excellent, ranging from 14 to 16 candle-power. The double-coil filament of Fig. 5 gives considerably better distribution in the vertical plane than any of those previously mentioned, but its horizontal distribution is less symmetrical than that of the other filaments.

The latest development in this direction is a spiral filament, represented diagrammatically in Fig. 6. A lamp having a filament of this sort is manufactured by the Sterling Electrical Manufacturing Company, Warren, Ohio, and is illustrated in perspective by Fig. 7. Referring to the diagram of light distribution, this shows perfect symmetry in both the vertical and horizontal planes, 16 candle-power being obtained at each of the angles. The manufacturers state that this result is actually obtained by photometric measurements with the lamp stationary. These lamps are manufactured in the usual voltages and candle-powers, and supplied with standard bases to fit all commercial sockets.

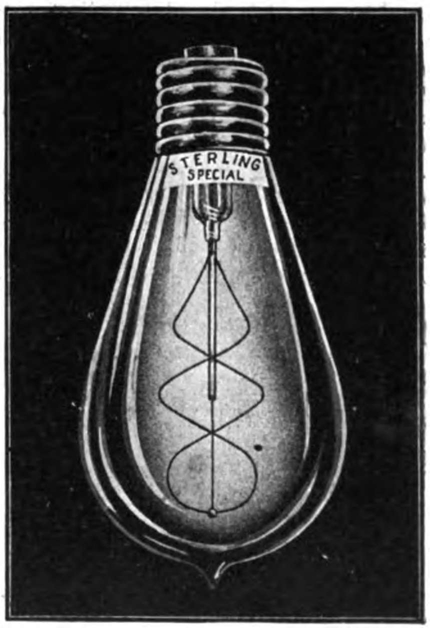


FIG. 7.—STERLING INCANDESCENT LAMP.

* * *

A Correction.—On page 426 of the September number of this paper, about halfway down the first column, the statement is made that a 100-kw. Onondaga dynamo is belted to a Skinner engine in one of the service plants at the Pan-American Exposition. We are advised by the builders that this machine is not belted, but direct-connected to the engine.

New Apparatus and Appliances

HALSEY DIRECT CURRENT METER.

The engravings herewith, Figs. 1, 2 and 3, illustrate the several parts and interior arrangement of the latest form of the Halsey meter, which was described at length in our last issue. Fig. 2 shows the aluminum frame adapted to carry the top bearing and the integrating mechanism, and shows also the fiber top of the mercury and armature-containing receptacle, which is a 4½-in. disc punched from ⅛-in. fiber; the engraving also shows the top pole-piece or stud of ⅞-in. soft iron that is pressed down through the fiber disc so as to be just flush with the interior wall of the chamber, together with the two copper electrodes passing down through the fiber close to the pole-piece, one on each side, so that the current in passing from one to the other will traverse the copper armature disc and the mercury in which it is submerged, radially through the center of the magnetic field. The solid copper disc, which is shown dropped down a short distance from the fiber cover, serves both as armature and as a brake for the meter; it is 3⅝ ins. in diameter and 1/16 thick, and its surface is completely amalgamated. This disc is mounted on a small nickel hub, which is swaged on a small spring steel shaft about 1/16 in. in diameter; the shaft carries at the top a removable worm to engage the recording mechanism. The worm is removable in order to allow the passing on of the concentric weight with the tight-fitting rubber gasket cemented to it, which serves to compensate for the excess buoyancy of the armature in the mercury and also to seal the receptacle mercury tight when the instrument is in transit.

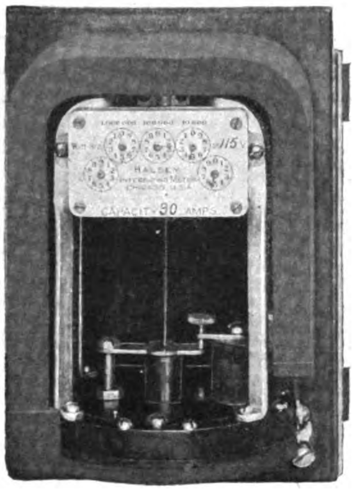


FIG. 1—HALSEY METER.

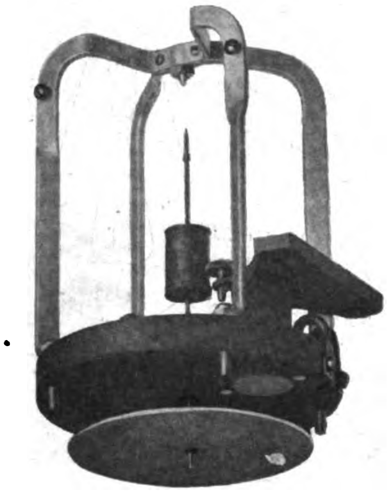


FIG. 2.—MERCURY CHAMBER.

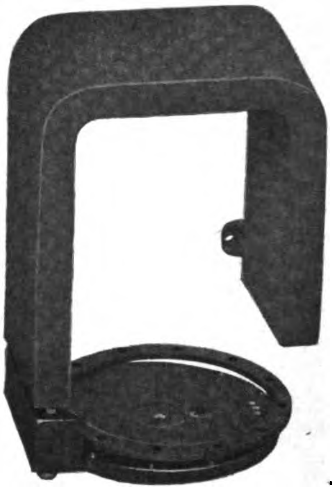


FIG. 3.—MAGNET.

The bottom of this receptacle is a cast-iron disc with a junction lug at the left side; it is shown in Fig. 3. It also acts as the bottom pole-piece and is separated from the top pole-piece and fiber disc by the ⅛-in. fiber ring washer shown with it, which determines the dimensions of the interior cavity and the field gap in which the armature disc revolves. The fiber top and the iron bottom are bound firmly together on the ring washer by 12 screws, under the heads of four of which the legs of the frame are also held. The cast magnet is shown in this engraving slightly separated from the junction lug of the bottom plate, to which it is normally clamped by two screws. The other end of the magnet makes connection normally with the top pole-piece through the medium of the soft iron stamping shown screwed to it in Fig. 1. A glimpse of the speed regulator is had at the right side of the bottom plate.

IMPROVED PORTABLE TESTING SETS.

Fig. 4 herewith shows a new model of the "Aone" portable testing set made by E. G. Willyoung, of New York. The set has been designed with special reference to convenience of manipulation, lightness and compactness; the complete set weighing about 7 lbs., and measuring 11 x 5⅝ x 4⅝ ins. over all. The bridge arms are reversible, with ratio coils of 1, 10 and 100 on one side, and 10, 100 and 1000 on the other. The maximum range of the instrument is therefore from 0.001 ohm to 21 megohms. The rheostat arm has 17 coils, ranging from 1 to 100,000 ohms, an open gap giving a balance on short circuits. The galvanometer is of the jeweled D'Arsonval

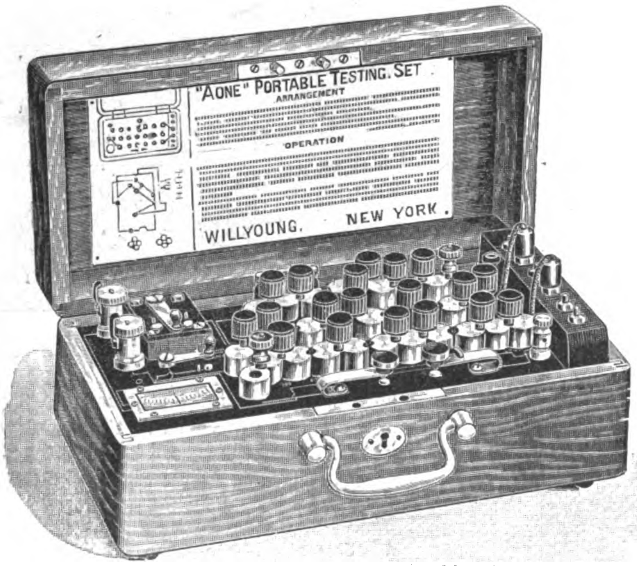


FIG 4.—PORTABLE TESTING SET.

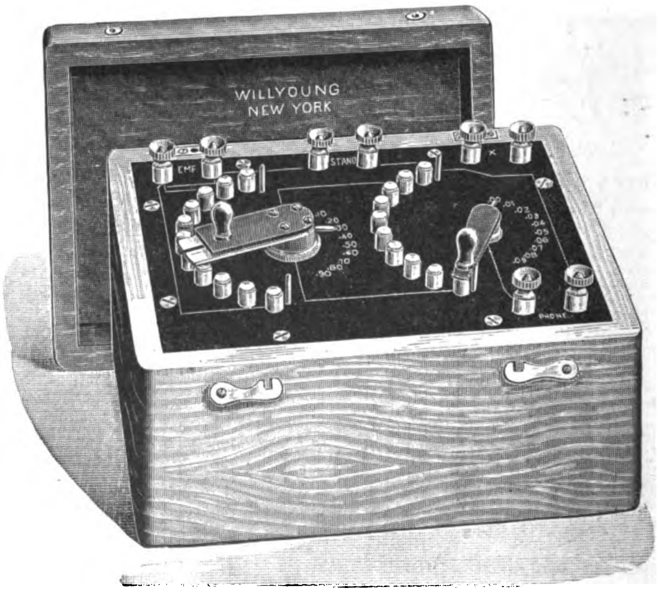


FIG. 5.—FARADMETER.

type, having a constant of about two megohms per volt per division. The battery consists of five semi-dry cells, each having an e.m.f. of over one volt. Connection is made by spring studs on the hard rubber top, which is fastened by bolts from beneath. The cells are readily replaced by merely removing the top of the cell container. Two special binding posts are provided for outside battery connection when it is desirable to measure resistances greater than 21 megohms. A shunt is also provided, as shown in the upper left-hand corner, for measuring still higher resistances by the direct deflection method. In making very delicate measurements an outside galvanometer may be used by joining it to the two posts so marked, and throwing a switch provided for that purpose. Special provision is made for the Varley and Murray loop-tests, the shifting of a pair of plugs putting everything in place for the tests. Among the tests claimed as possible to this set are: Resistance in general, conductivity, insulation, location of faults by the Murray and Varley loop methods, testing in open and short circuits, as a potentiometer in the measurement of e.m.f. and current, calibration of ammeters and voltmeters, testing the internal resistance of batteries, the measurement of self-induction, etc.

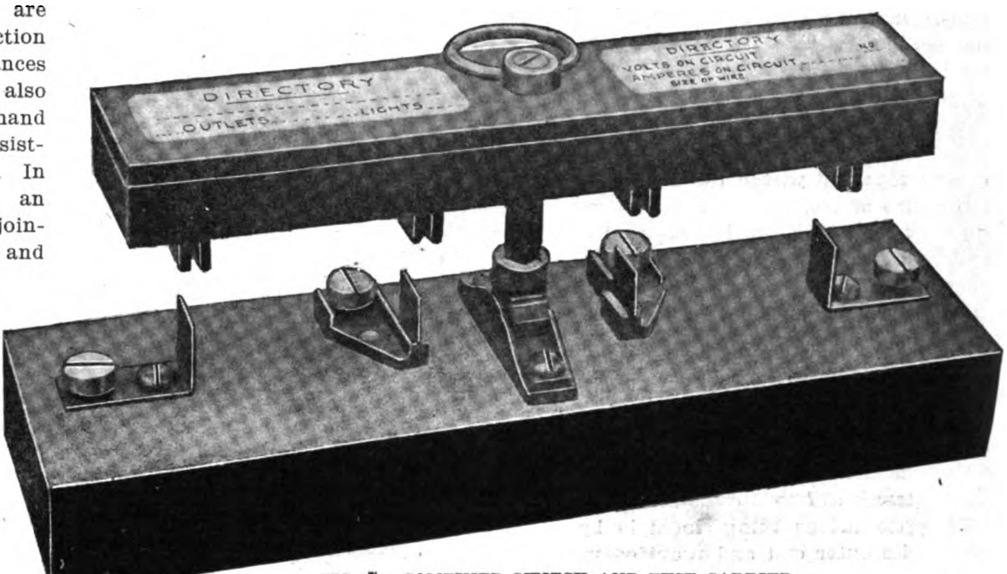


FIG. 7.- COMBINED SWITCH AND FUSE CARRIER.

Fig. 5 shows a faradmeter designed by Mr. Willyoung for capacity tests. It is essentially a Wheatstone bridge on the Varley slide principle. The power is supplied by a source of alternating current. A telephone receiver is used in place of a galvanometer. Two dials are provided, one reading to the first, and the other reading to the second decimal place. The capacity is thus given to one part in one hundred. The instrument is said to be quick and positive in its action, and to give results quite independent of leakage and absorption. The manufacturer claims that it can be used anywhere, regardless of neighboring mechanical or electrical disturbances.

NEW QUICK-BREAK SWITCH.

A new quick-break switch made by Zimdars & Hunt, of New York, and which is claimed to meet successfully the most severe service to which this type of switch is subjected, is shown by Fig. 6. The principal features of the design are clearly shown in the engraving. Helical springs connect the handle to the blade, which is held firmly in the jaws. When opening the switch, the springs are fully elongated before the blade moves, since their tension is not sufficient to draw the blade from between the jaws. A further movement of the handle, however, brings the finger on the lower end of the handle against the bottom of the blade and starts it from its position. As soon as the blade nears the top of the jaws, where their tension is less, it flies open instantaneously under the action of the springs. Arcing at the main contacts is eliminated by supplying the switches with auxiliary carbon contact blocks. The manufacturers claim that owing to the liberal contact and sectional areas provided, there is no undue heating even under a considerable load.

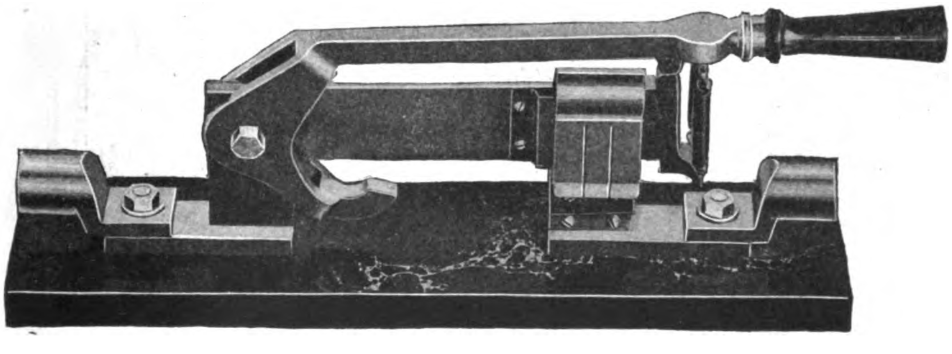


FIG. 6.—QUICK-BREAK SWITCH.

PANEL BOARD WITH REMOVABLE ENCLOSED FUSE CARRIER.

The accompanying illustrations show a new type of enclosed fuse carrier and panel board which is being placed on the market by the General Incandescent Arc Light Company of New York. Fig. 8 shows a panel board for six circuits on a two-wire main, and Fig. 7 shows a combined switch and enclosed fuse carrier. It will be seen that the latter embodies the functions of a knife switch, a removable fuse holder and an enclosed fuse. To use the carrier as a switch it is merely pulled out by means of the ring handle. The fuses used are the plain standard link open type; but by being enclosed in these carriers they are said to possess all the advantages of the enclosed type of fuses. To renew a fuse the carrier is removed by simply taking out a screw, thus obviating the risk of short circuits through the use of a screw-driver near a live circuit. Each fuse carrier is designed to receive a directory card on which can be written, under properly printed headings, the number of outlets, lights and locations, the size of wire, together with the amperes and volts on circuit. This information being labeled directly at the point where the circuit is controlled is obviously very convenient. The carriers are designed for a minimum capacity of 10 amperes at 125 volts, and the main fuse bus-bars are figured to carry 6 amperes per circuit.

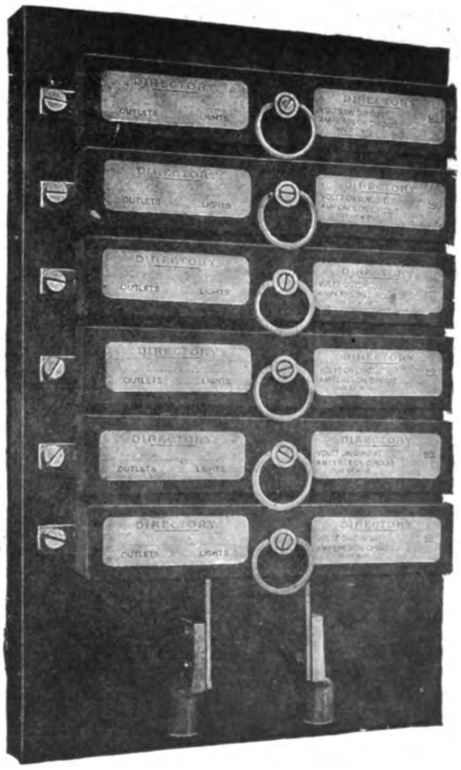


FIG. 8.—PANEL BOARD.

THE POTTER MESH SEPARATOR AND SUPERHEATER.

A departure in separator practice is embodied in the superheating separator illustrated herewith and the method of its utilization. As is well known, where a separator is used it is customary to insert it in the line of steam pipe as near as possible to the delivery end of the pipe. The method of using the separator here illustrated is exactly the opposite of this, the apparatus combining the function of a superheater with that of a separator. It is placed at the boiler end of the steam delivery pipe and within the boiler shell. In the case of sectional boilers, the separator is placed inside of the steam drum, and in all cases it delivers directly to the boiler nozzle.

The separator consists of a number of metal bands having an oval outline and being clamped together side by side with partitions of wire gauze between, as shown clearly in the accompanying engraving. The structure composed of these sections is flanked at each end by a tubular extension of oval cross-section, one of these extensions being closed in by a head at its outer end and provided with a delivery outlet on one of the flat sides. The other extension is shorter and serves merely as a sort of clamping ring to give rigidity to the structure. The steam enters the structure at the open end, of course, and, after filtering through the consecutive partitions of wire cloth, is delivered at the outlet end to the boiler nozzle.

It is claimed that the steam is superheated in its passage through the apparatus, and it follows, of course, that when the stream is delivered to the boiler nozzle it is entirely free from suspended or entrained moisture. It is explained that the layers of wire cloth absorb to a large extent the pulsations due to the motion of the engine piston and thereby reduce the tendency to lift water. The small globules of moisture which are always contained in steam taken directly from the steam space of a boiler are broken up by the first gauze partition, still further disintegrated by the second partition, and so on, until the moisture is completely atomized and requires only a small degree of superheating to be flashed into dry steam. This superheat is obtained by the slight wire drawing consequent upon passing through the gauze, the reduction in pressure on this account, it is stated, being about one per cent. It is unnecessary to explain the effect of delivering superheated steam to the mains. The new separator is marketed by Jas. Beggs & Co., New York, general sales agents.

The builders state that a test of the apparatus made with the calorimeter located 2½ ins. from the bottom of the steam delivery pipe showed three-tenths of one per cent of moisture, as compared with three-fourths of one per cent found in a test under the same conditions without the separator.

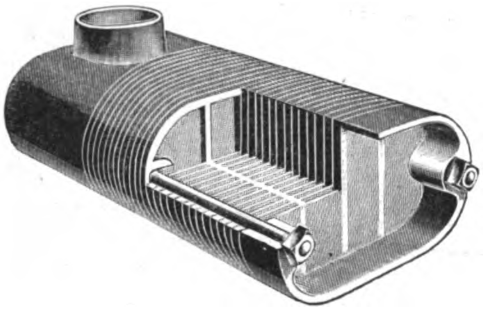


FIG. 9.—SEPARATOR AND SUPERHEATER.

TURBINES IN THE COMSTOCK MINE POWER PLANT.

Fig. 10 herewith illustrates a pair of 27-in. McCormick turbines mounted in an iron case on a horizontal shaft direct-connected to an alternating-current generator; two of these settings complete were built by the S. Morgan Smith Company, of York, Pa., for the power house of the Truckee River General Electric Company, of Floriston, Cal., where they develop 1400 horsepower at 400 r.p.m. when operated under a head of 84 ft. The extra pressure under the wheel case and supply pipes caused by the heavy changes of load is taken care of by a Ludlow relief valve working in connection with a Lombard water-wheel governor. The plant also contains two smaller McCormick turbines, direct-connected to the exciters. The power is transmitted 35 miles to the celebrated Comstock mines, where it is used for pumping water and operating mining machinery.

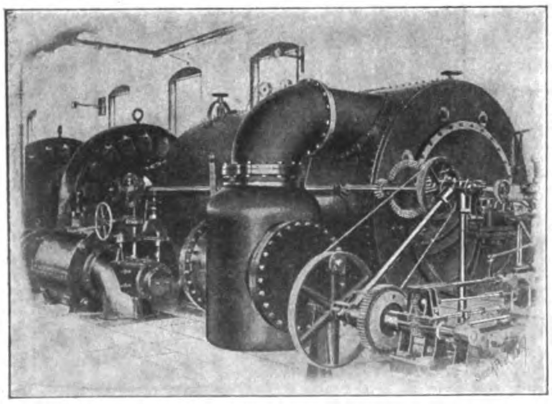


FIG. 10.—TRUCKEE RIVER GENERATING PLANT.

ELECTRIC MOTORS IN SURGICAL OPERATIONS.

Fig. 11 shows a Lundell motor which has been installed in the operating room of the Presbyterian Hospital of New York, and used with gratifying results; the operations, it is said, being performed in much shorter time and with less pain to the patients than was the case with the older methods. The motor is mounted on a universal bracket and has a flexible shaft, with a special chuck at the end for receiving the surgical instruments used for trepanning the skull, and sawing and drilling the bones. The method of attaching the shaft, and the general method of supporting the motor, enable it to be operated at a very high speed with maximum power and without vibration while guiding it with the hand. This interesting application of the electric motor to surgical work was made by the Sprague Electric Company.

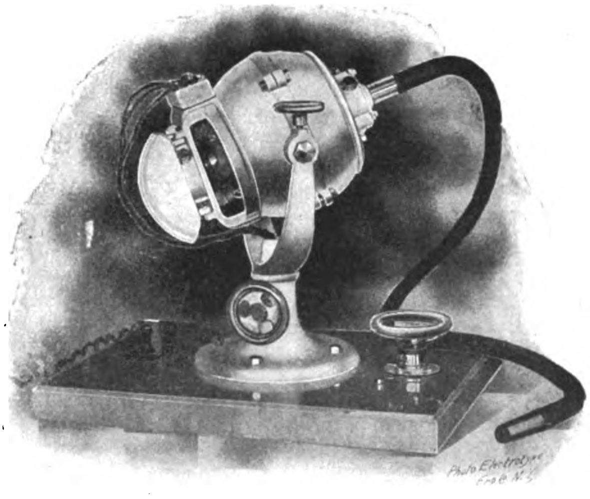


FIG 11.—LUNDELL MOTOR.

BULB CLEANER AND LAMP REPLACER.

Two handy devices made by the Incandescent Electric Light Manipular Company, Boston, for cleaning or replacing incandescent lamps, are illustrated by Fig. 12. The instrument, the maker claims, will replace any incandescent lamp of standard make at any height or angle, or clean the same without removing it from its socket, as well as can be done by hand. The jaws are normally held open by a spring, and the ratchet shown at the bottom of the engraving serves to hold them closed to any degree of tightness. The handles are made in one piece or telescopic, of either light gauge steel or aluminum tubing; a 10-ft. replacer weighing but 3 lbs. and a 20-ft. replacer weighing less than 5 lbs. A small device may also be attached to the instrument whereby it may serve as a switch and socket-key manipulator. In cleaning the bulbs the cleansing material is fastened in the jaws of the instrument. The style of instrument shown at the left

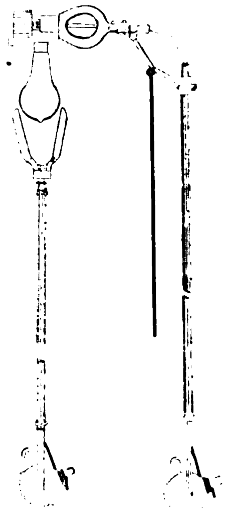


FIG. 12.

of the engraving is made for street lamps or any others which may be handled by a straight reach, while the other style is said to be invaluable for halls, hotels, theaters, etc., where the lamps are placed at an angle.

HANDY TABLES FOR ENGINEERS.

Recipients of the pamphlet of Handy Tables, issued last January, are requested to cut out the accompanying table of Electrical Horse-power and paste it over the original table in the pamphlet. A small error runs uniformly through a section of the original table, indicating that the calculating machine by means of which the table was computed became disturbed after having been set for this table.

Table VII. - Electrical Horse-Power.

Numbers in the body of the table are Amperes required to give the Horse-power in the side columns, at the Voltage given at the top of each column.

	Voltage at point of delivery.						Voltage at point of delivery.				
H.P.	110	115	220	230	500	H.P.	110	115	220	230	500
¼	1.695	1.622	0.848	0.811	0.373	47	318.76	304.9	159.4	152.45	70.13
½	3.39	3.243	1.695	1.622	0.746	48	325.54	311.4	162.76	155.68	71.62
¾	5.09	4.865	2.543	2.432	1.119	49	332.3	317.8	166.16	158.92	73.11
1	6.78	6.487	3.39	3.243	1.492	50	339.1	324.35	169.55	162.17	74.6
1½	10.17	9.731	5.09	4.865	2.238	51	345.88	330.8	172.94	165.4	76.09
2	13.56	12.974	6.78	6.487	2.984	52	352.65	337.3	176.32	168.65	77.58
2½	16.95	16.218	8.48	8.109	3.73	53	359.43	343.8	179.72	171.9	79.08
3	20.35	19.46	10.17	9.731	4.476	54	366.2	350.3	183.11	175.14	80.57
4	27.13	25.95	13.56	12.974	5.968	55	373.	356.8	186.5	178.89	82.06
5	33.91	32.435	16.95	16.218	7.46	56	379.8	363.3	189.9	181.63	83.55
6	40.69	38.923	20.35	19.46	8.952	57	386.57	369.7	193.3	184.87	85.04
7	47.48	45.41	23.74	22.705	10.444	58	393.35	376.2	196.7	188.12	86.54
8	54.26	51.9	27.13	25.95	11.936	59	400.15	382.7	200.1	191.36	88.03
9	61.04	58.385	30.52	29.19	13.428	60	406.91	389.2	203.46	194.6	89.52
10	67.82	64.873	33.91	32.435	14.92	61	413.7	395.7	206.85	197.85	91.02
11	74.6	71.36	37.3	35.68	16.412	62	420.49	402.2	210.25	201.1	92.5
12	81.39	77.85	40.69	38.923	17.905	63	427.26	408.7	213.63	204.33	94.
13	88.17	84.33	44.08	42.166	19.396	64	434.05	415.2	217.02	207.58	95.49
14	94.95	90.82	47.48	45.41	20.89	65	440.8	421.6	220.4	210.82	96.98
15	101.74	97.31	50.87	48.655	22.38	66	447.6	428.1	223.8	214.07	98.47
16	108.51	103.79	54.26	51.9	23.872	67	454.4	434.6	227.2	217.3	99.96
17	115.29	110.28	57.65	55.14	25.365	68	461.2	441.1	230.6	220.55	101.46
18	122.08	116.77	61.04	58.385	26.856	69	467.95	447.6	234.	223.8	102.96
19	128.86	123.25	64.43	61.615	28.35	70	474.75	454.1	237.4	227.05	104.44
20	135.64	129.74	67.82	64.873	29.84	71	481.5	460.6	240.75	230.3	105.93
21	142.42	136.23	71.22	68.12	31.332	72	488.3	467.05	244.15	233.5	107.42
22	149.2	142.71	74.6	71.36	32.825	73	495.1	473.55	247.54	236.75	108.92
23	156.	149.2	78.	74.6	34.317	74	501.85	480.	250.93	240.	110.41
24	162.76	155.68	81.39	77.85	35.81	75	508.65	486.5	254.32	243.25	111.9
25	169.55	162.17	84.78	81.09	37.3	76	515.41	493.	257.7	246.5	113.4
26	176.32	168.65	88.17	84.33	38.795	77	522.2	499.5	261.1	249.74	114.89
27	183.11	175.14	91.56	87.58	40.284	78	529.	506.	264.5	253.	116.38
28	189.9	181.63	94.95	90.82	41.775	79	535.79	512.5	267.9	256.22	117.86
29	196.7	188.12	98.34	94.06	43.27	80	542.58	519.	271.3	259.47	119.36
30	203.46	194.6	101.74	97.31	44.762	81	549.35	525.4	274.7	262.7	120.85
31	210.25	201.1	105.12	100.55	46.251	82	556.1	531.9	278.1	265.95	122.35
32	217.02	207.58	108.51	103.79	47.746	83	562.9	538.4	281.45	269.2	123.85
33	223.8	214.7	111.9	107.04	49.24	84	569.7	544.9	284.85	272.45	125.33
34	230.6	220.55	115.29	110.28	50.73	85	576.5	551.4	288.24	275.7	126.82
35	237.4	227.05	118.69	113.52	52.22	86	583.25	557.9	291.62	278.9	128.31
36	244.15	233.5	122.08	116.77	53.712	87	590.	564.4	295.	282.2	129.8
37	250.93	240.	125.46	120.	55.206	88	596.8	570.8	298.4	285.4	131.3
38	257.7	246.5	128.86	123.25	56.7	89	603.6	577.4	301.8	288.7	132.8
39	264.5	253.	132.25	126.5	58.19	90	610.4	583.8	305.2	291.9	134.28
40	271.3	259.47	135.64	129.74	59.68	91	617.15	590.3	308.6	295.2	135.77
41	278.1	265.95	139.02	132.98	61.175	92	623.95	596.8	312.	298.4	137.26
42	284.85	272.45	142.42	136.23	62.667	93	630.7	603.3	315.36	301.6	138.75
43	291.62	278.9	145.8	139.47	64.157	94	637.5	609.8	318.76	304.9	140.25
44	298.4	285.4	149.2	142.71	65.65	96	651.1	622.8	325.54	311.4	143.23
45	305.2	291.9	152.6	145.95	67.14	98	664.6	635.7	332.3	317.8	146.21
46	312.	298.4	156.	149.2	68.635	100	678.2	648.7	339.1	324.35	149.2

Example: Current required at 230 volts to transmit 75 horse-power. In the column under 230, opposite 75 in the Horse-power olumn, is found the number 243.25, which is the required number of amperes.

OBITUARY.

GEORGE MASON, president of the Potomac Terra Cotta Company, of Washington, D. C., died of heart failure on September 1, after an illness of some days. Mr. Mason was a self-made man, prepared himself, without assistance, for admission to the University of Vermont, from which he graduated in 1858, and afterward received the degree of A. M. In 1863 Mr. Mason went to Washington, where he resided up to the time of his death. For the first five years of his residence there he occupied a position in the office of the paymaster general of the army. He was admitted to the bar of the District of Columbia, and practiced his profession for several years, making a specialty of bankruptcy cases. In 1894 he purchased a controlling interest in the Potomac Terra Cotta Company, a large manufacturer of electrical conduits, and became its president.

PERSONALS.

MR. R. H. BEACH, manager of the General Electric Company's railway department, returned recently from a successful four weeks' tour of Mexico.

MR. CAMPBELL SCOTT, secretary and general manager of the C & C Electric Company, has gone to Europe on a four weeks' business trip. Most of his time will be spent in London.

MR. FREDERICK WENDELL HUME, who has been for some time associated with the Western Electric Company, has joined the staff of the Electric Storage Battery Company, Philadelphia, Pa.

MR. J. S. O'DONOVAN, formerly chief electrician of the Republic Iron & Steel Company, Youngstown, Ohio, has resigned this position to take a similar one with the Youngstown Iron Sheet & Tube Company in the same city.

MR. GEORGE BULLOCK, president of the Bullock Electric Manufacturing Company, of Cincinnati, Ohio, has returned from a trip to Europe, where he went to establish a branch plant to supply the English and European trade with the machines and appliances manufactured by his company.

PROF. WM. S. ALDRICH, who was for several years professor of electrical engineering at the University of Illinois, has been appointed to the directorship of the Thos. S. Clarkson School of Technology, Potsdam, N. Y. The Clarkson School is to be congratulated upon the acquisition of Prof. Aldrich's services, the value of which is too well recognized to require eulogy.

MR. N. WETMORE HALSEY, for many years associated with N. W. Harris & Co., bankers, and for the past ten years resident managing partner at their New York office, announces the organization of a new firm under the name of N. W. Halsey & Co., to conduct a general banking business and deal in railroad bonds and other investment securities. The offices of the new firm are at 49 Wall Street, New York.

MR. R. C. P. HOLMES, the purchasing agent of the Chicago Edison Company, met with an unfortunate accident on September 6, while riding on an Illinois Central suburban train. He was on the last car of the train, and while lighting a cigar, fell off the platform, breaking his collar bone and three of his ribs, and receiving a severe scalp wound. Mr. Holmes has the sympathy of his many friends, who wish for his speedy recovery.

MR. H. L. SHIPPY, manager of the New York office of John A. Roebling's Sons Company, had a narrow escape recently on the occasion of the wrecking of the McCormick steam yacht "Rapidan" off the coast of Delaware. The pleasure party and the crew were landed with enormous difficulty in surf boats, the life saving corps having found the use of a breeches buoy impracticable. Mr. Shippy is one of the most popular men in electrical circles, and has been deluged with congratulations on his fortunate escape.

MR. W. WAMPLER, recently connected with the Peckham Manufacturing Company, has been appointed district representative of the Stuart-Howland Company, Boston, for the sale of that company's railway supplies in New York, Pennsylvania, Delaware, New Jersey and Maryland. Mr. Wampler has had twelve and a half years of experience in street-railway work, and is thoroughly familiar with all of its details. He was for some time mechanical superintendent for the Union Railway Company, New York, and later filled a similar position with the Atlantic Avenue road in Brooklyn.

MR. W. S. BARSTOW, who was the efficient general manager of the Edison Electric Illuminating Company of Brooklyn from 1889 to 1901, has opened an office as consulting engineer at 11 Broadway, New York City. Mr. Barstow expects to devote a large part of his time to the development of street-railway undertakings, and has already been retained by Spencer, Trask & Co. as consulting engineer for all of their numerous electrical properties, both railway and lighting. Mr. Barstow graduated from Columbia University in 1887, and after a period of service in the Edison Machine Works at Schenectady he joined the Brooklyn company. His wide knowledge of both the financial and technical branches of electrical enterprises gives his opinion upon these matters great weight.

BUFFALO EXPOSITION VISITORS.—Below is a list of visitors recently registered at the booth of the American Electrician in Electricity Building, at the Pan-American

Exposition: W. S. Bennett, New York; C. J. Bogue, New York; E. Bracken, St. Catherines, Ont.; Alfred I. Brown, Cincinnati, Ohio; R. L. Bruce, Pittsburg, Pa.; Thos. H. Capener, Cleveland, Ohio; F. J. Carlton, Toledo, Ohio; D. R. Clayton, Athens, Ohio; G. E. Cornisch, Oswego, N. Y.; E. H. Couwbe, London, England; W. A. Davis, Buffalo, N. Y.; T. Defor, Bay City, Mich.; M. Dings, Milwaukee, Wis.; Edward Durant, New York; A. H. Ford, Buffalo, N. Y.; J. T. Freeman, Rochester, N. Y.; Ralph A. Garrison, Albany, N. Y.; Walter J. Garside, London, Ont.; Walter Gummey, Depew, N. Y.; Geo. A. Harris, Birmingham, Ala.; Geo. E. Holton, Catasauqua, Pa.; J. M. Howard, Ogdensburg, N. Y.; Arthur Hull, Cayuga, Ont.; J. D. Kieley, Brooklyn, N. Y.; P. J. Kruesi, New York; Claude E. H. Law, Solina, Ont.; D. B. Long, Buffalo, N. Y.; J. S. McBride, Pittsburg, Pa.; F. E. McNall, Medina, N. Y.; A. H. Mitchell, Thayer's Corners, N. Y.; E. F. Morrill, Brooklyn, N. Y.; A. J. Nixon, Richmond, Ohio; Alex. F. Ormsbee, Brooklyn, N. Y.; A. E. Payne, Montreal, Can.; Wm. M. Porter, Elwood, Ind.; Arthur H. Potts, London, Eng.; I. F. Shepard, Cincinnati, Ohio; F. J. Skinner, Boston, Mass.; C. N. Smith, Cleveland, Ohio; Geo. R. Smith, Solsville, N. Y.; W. N. Smith, New York; C. W. Squire, Bloomfield, N. J.; J. C. Stut, San Francisco, Cal.; Willis L. Towne, Amherst, Mass.; C. H. Tyndall, Mt. Vernon, N. Y.; T. J. Vanar, Detroit, Mich.; O. W. Visscher, Holland, Mich.; Henry Watts, Brooklyn, N. Y.; G. Wiebe, Halstead, Kan.; F. A. Williams, New York, and Samuel B. Zerfou, Harrisburg, Pa.

◆

TRADE PUBLICATIONS.

ASBESTOS PACKINGS. H. W. Johns Manufacturing Company, New York.—A pocket-size pamphlet, containing illustrations of boilers on which asbestos packings are used.

SNOW PLOWS AND TRACK SCRAPERS. J. G. Brill Company, Philadelphia.—Catalogue No. 68, containing illustrations and descriptions of the Brill snow plows, combination snow plow and construction car, and Brill track scraper.

INCANDESCENT LAMPS. The Colonial Electric Company, Ravenna, Ohio.—A catalogue of standard size, well executed, containing full-size illustrations of Colonial incandescent lamps, which are made in all candle-powers, styles and bases.

PERU FUSIBLE ATTACHMENT PLUGS. Peru Electric Manufacturing Company, Peru, Ind.—A vest-pocket pamphlet, containing illustrations and prices of the Peru porcelain attachment plugs, which are provided with a double-pole fuse cap.

ERICSSON INTERCOMMUNICATING TELEPHONE SYSTEM. Ericsson Telephone Company, New York.—This is Part 6 of the Ericsson series of leaflets devoted to the explanation of telephone apparatus. The present pamphlet contains a diagram and description of the Ericsson intercommunicating system.

KNECHT SENSITIVE-FRICTION DRILL PRESS. The Knecht Brothers Company, Cincinnati, Ohio.—A pocket-size catalogue of the Knecht friction drill press, in which an unusual arrangement of friction gearing is employed. The machine is designed to drill holes up to 9/16 in. in diameter, and weighs 530 lbs., boxed.

STANDARD TWIST DRILLS, REAMERS, ETC. The Standard Tool Company, Cleveland, Ohio.—A pocket-size pamphlet, containing illustrations of the well-known Standard twist drills, machine-screw taps, reamers and drill chucks, with descriptive matter printed in Spanish. This edition is prepared especially for circulation in Mexico and South American countries.

ELECTRIC COAL-MINING MACHINERY. Goodman Manufacturing Company, Chicago.—This is Catalogue A, containing illustrations and descriptions of the Goodman electric chain breast coal-cutting machine and its parts, together with illustrations and price lists of the various electrical appliances and supplies used in the construction of trolley and feeder lines for mines.

GASOLINE SOLDERING FURNACES AND TORCHES. Clayton & Lambert Manufacturing Company, Detroit, Mich.—This is a small pamphlet catalogue, illustrating the well-known line of gasoline torches and firepots made by this company. The catalogue also contains illustrations and descriptions of the company's latest alcohol torches, which are made in vest-pocket size.

TELEPHONE APPARATUS. Eureka Electric Company, Chicago.—A pamphlet catalogue, illustrating the extensive Eureka line, which includes instruments for every conceivable class of service. The catalogue also contains illustrations of various individual pieces of apparatus and parts, such as cable terminal junction heads, induction coils, receiver cases, switchboard generators, extension bells, etc.

ELECTRIC LOCOMOTIVES. The Jeffrey Manufacturing Company, Columbus, Ohio.—This is Catalogue No. 18, in which are illustrated and described the Jeffrey Company's various types of electric locomotives for mining service. These range from 4000 to 40,000 lbs. in weight and from 500 to 8000 lbs. drawbar pull. The catalogue also contains interesting illustrations of Jeffrey mining locomotives in actual service.

"STEAM." The Babcock & Wilcox Company, New York.—This is the thirty-second edition of this universally known book, which is already so familiar to steam users that an analytical review would be almost an aspersion upon their intelligence. The present edition is more ornately executed than its predecessors, and contains some new illustrations, notable among which are views of the Metropolitan Railway power house at 96th Street, New York.

A CLEVER ARGUMENT.—C. J. Toerring Company, Philadelphia, is sending out a very clever advertisement in the form of a blotter, bearing a tinted illustration of a vessel making for harbor, and the legend "Dividends Harbor is accessible to all who use Toerring enclosed arc lamps as a beacon." The blotter also contains the statement that "the lamps pick up promptly, leave the humming to the bird of that name, and, like all good children, they are seen but not heard."

A MISTAKE CORRECTED. Farr Telephone & Construction Supply Company, Chicago.—A leaflet, in which the Farr Company points out that those who may think that the company makes only a cheap grade of goods are mistaken, the fact being that this company is manufacturing telephone apparatus of the very highest grade, including magneto bells with five-bar magnets and laminated armatures, to ring through 50,000 to 100,000 ohms. The leaflet contains a large number of testimonials from users of Farr telephones, all of which are dated within the present year.

PAN-AMERICAN SOUVENIR. The Westinghouse Companies.—This is a highly ornamental brochure, prepared especially for distribution at the Pan-American Exposition, and containing synoptical information regarding the various Westinghouse companies and their products. The pamphlet is handsomely illustrated by half-tone engravings showing views of the Westinghouse Machine Company's and the Westinghouse Electric Manufacturing Company's works; Westinghouse generators, motors, engines, street-railway electrical equipment, brakes, etc. One of the most interesting features of the book is a diagrammatic illustration showing the distribution of power from the Niagara Falls generating station. This diagram, occupying a space 7 ins. square, gives as much information as could be imparted by several hundred words of text, and in a much more comprehensible manner.

◆

BUSINESS NEWS.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has put on the market a new cabinet type of wall telephone set for series and bridging work.

THE QUINCY ENGINE WORKS, Quincy, Ill., has added to its product a line of vertical compound engines in sizes from 400 to 2,500 horse-power, built specially for service in electric-lighting and power plants.

CATALOGUES WANTED.—The Federal Electric Company, 141 Broadway, New York, wishes to receive catalogues from the manufacturers of electrical apparatus, to be sent abroad and filed in a foreign library.

A COMMUTATOR NECESSITY.

For Sale by all Supply Houses.
Upon receipt of this coupon we will send FREE, sample stick.

Name..
Address..
A. E.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.
50c. per Stick. $5 00 per Dozen.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, recently installed one of the largest Cross oil filters ever made, in the power-house of the Edison Electric Illuminating Company, Brooklyn, N. Y.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, Warren, Ohio, manufacturer of the new Sterling incandescent lamp, has appointed Francis Granger, 26 Cortlandt Street, as the New York agent for the sale of this lamp.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, reports that it is "snowed under" with orders, and that the factory is working to its utmost limit, twenty-four hours a day, in the effort to keep abreast of the gratifying volume of business.

GEORGE W. LORD, of Philadelphia, the well-known manufacturer of Lord's boiler compounds, has just opened an office and warerooms at Bradford, England, which will be in charge of Fred Brown. Mr. Brown sailed on September 28 to assume his new duties.

UNION STEAM PUMP COMPANY, Battle Creek, Mich., advises us that a convention of its selling agents and representatives, distributed throughout the United States and Canada, was held at Battle Creek, September 24, 25 and 26, and that the convention was an extremely successful one.

W. H. ANDERSON & SONS, Detroit, Mich., manufacturers of line construction tools and materials, have just moved into their new factory building, which is equipped with the most modern machinery, and has twice the capacity of the old factory. The firm is now in position to take prompt care of its rapidly growing business.

J. J. REIDY, New Haven, Conn., manufacturer of Donnelly's improved steel climbers, states that the Manhattan Electrical Supply Company, Chicago; the McIntosh, Huntington Company, Cleveland, Ohio, and W. B. Belknap & Co., Louisville, Ky., carry large stocks of these climbers, and can supply smaller dealers at factory prices.

U. S. ELECTRIC CONTRACTING COMPANY, Syracuse, N. Y., has been organized by David Cronin (who becomes president of the company) and has succeeded to Mr. Cronin's business. The new company will manufacture the Younglove & Gere woven-wire dynamo and motor brushes, and extend the large contract business already built up by Mr. Cronin.

THE MOUND TOOL AND SCRAPER COMPANY, St. Louis, Mo., has established a western distributing point at 58 First Street, San Francisco, Cal., the office of C. W. Marwedel, who will carry a full stock of the company's specialties, so that engineers on the Pacific coast may obtain these tools without the delay incident to ordering direct from the factory.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, recently obtained the exclusive territorial selling agency for the new type Peerless incandescent lamp. The company states that the factory has been experimenting on this lamp for the last two or three years, and now has a lamp which is as perfect, both mechanically and electrically, as such lamps can be made in the present state of the art.

THE CLARKE AUTOMATIC SCALES COMPANY has removed its offices from 71 Broadway to 29 Broadway, New York. This company states that engineers and managers of electric lighting and power plants are realizing more and more the necessity for watching closely the disposition of their coal pile, and coming to recognize the fact that automatic scales play an important part in central-power-station equipment.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., is putting out a new lamp hanger-board with absolute cut-out, adapted for series direct-current or alternating-current lamps, and for both indoor and outdoor service. The new hanger-board is known as type S. L. It is made of heavy porcelain, and protected by a black enameled hood. The switch is said to be air- and water-tight, and has a ⅜-in. break.

THE HORN & BRANNEN MANUFACTURING COMPANY, Philadelphia, the well-known manufacturer of gas and electric-light fixtures, reports that the outlook for business was never brighter than it is this fall. The company has a number of new designs in the way of electrical fixtures that are taking well with the trade, and has recently issued two elaborate new catalogues, one of medium and the other of the highest grade fixtures.

THE NORTHERN ELECTRIC MANUFACTURING COMPANY, Madison, Wis., is about to more than double the size of its plant, and is preparing to build new offices for its executive staff. These new facilities will make this company one of the largest manufacturers of electrical machinery in the West, and the move is indicative of the fact that the "Northern" type of motors and generators is appealing strongly to electrical engineers.

WARREN PULLEY COVER.—The Warren Company, Chicago, calls attention to the fact that its preparation for increasing the efficiency of belt transmission is not put on the belt, as in the case of many other preparations of this class, but is applied to the face of the pulley, giving the latter a leather-like surface, which increases the grip of the belt. It is stated that this preparation does not wear smooth, as might be inferred, and that one application retains its tractive efficiency for a year or longer.

The Telephone Service is The Quickest Messenger.

Rates in Manhattan from $5 A MONTH. One Year Contracts. Monthly Payments.

NEW YORK TELEPHONE CO.
15 Dey Street. 111 West 38th Street.

CREAM FLUX

An Absolutely Non-Corrosive Insulating Soldering Flux FOR ALL METALS.

So EASILY APPLIED that all CAN USE IT.
So CHEAP that all SHOULD USE IT.
So EFFICIENT that all MUST USE IT.

PUT UP IN CANS AT
15c., 25c., 45c. and 75c.
SPECIAL PRICES IN QUANTITY.
SEND FOR TRIAL BOX.

Endorsed by the National Board of Fire Underwriters and all users.
We guarantee it, and if not satisfactory, money will be refunded.
FOR SALE BY ALL SUPPLY HOUSES OR

CREAM FLUX CO., SOLE MANUFACTURERS, 100 Washington St., CHICAGO

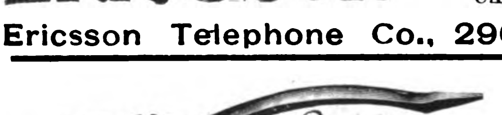
BIG STICK, 35 CENTS.
Sample Free.
SOUTHWORTH & HARE,
Indianapolis, Ind.

ERICSSON

Means best. Satisfaction guaranteed. No buzzing. Talks clear and distinct. Of neat appearance.

CATALOGUE FREE ON APPLICATION.

Ericsson Telephone Co., 296 Broadway. N. Y. City.



GIVEN AWAY!

A GREEN BOOK of Hardware Specialties, in which are illustrated only first class tools.

SEND FOR ONE.

UTICA DROP FORGE & TOOL CO., SMITH & HEMENWAY CO.,
Ask your dealer for these goods. 296 Broadway, New York City.

PLATINUM

PLATINUM FOR CONTACT POINTS IN ELECTRICAL INSTRUMENTS.
PLATINUM FOR TELEPHONES. PLATINUM FOR ELECTRICAL INSTRUMENTS.

We sell PLATINUM in any quantity, either large or small. We buy PLATINUM, or anything containing PLATINUM, in any quantity.

FOR INCANDESCENT LAMPS AND EVERYTHING ELSE.

BAKER & CO.

MANUFACTURERS OF PLATINUM IN ALL SHAPES.

Newark, N. J. New York Office, 120 Liberty St.

THE BANNER ELECTRIC COMPANY, Youngstown, Ohio, has equipped a new and commodious factory with the latest appliances for the production of incandescent lamps, and is in a position to supply all orders promptly, up to the present capacity of 4000 lamps per day. The company states that its technical staff consists of men thoroughly experienced in the manufacture of incandescent lamps, so that its business is not in any sense an experiment, and its product is expected to be as perfect as human skill and high-class machinery can turn out.

H. W. JOHNS MANUFACTURING COMPANY, New York, reports among recent sales of its well-known heat-insulating coverings the following: State Normal School, Fredonia, N. Y., "Nonburn" fire felt and sectional covering; Strathmore Apartments, New York City, "Asbestocel" covering; Youngstown (Ohio) Consolidated Gas & Electric Company, fire felt sectional covering and asbestos cement; Aetna Life Insurance Company, Hartford, Conn., fire felt covering and cement felting.

THE CLING-SURFACE MANUFACTURING COMPANY, Buffalo, N. Y., states that the Pan-American Exposition Company is using Cling-Surface on all of its belts, and that all of the belts of the United States Government exhibits have also been treated with Cling-Surface at the request of the government representatives on the grounds. It is further stated that nearly all of the belts used in the Midway shows have been treated with this preparation, and three-fourths of the exhibitors who use belt-driven machinery are deriving the advantage of Cling-Surface treatment for their belts also.

THE MASSACHUSETTS CHEMICAL COMPANY, Boston, Mass., among chemical products for electrical use, makes one known as Armalac, an insulating compound for armatures and fields; Enamelac, an insulating paint, particularly adapted for wet-battery work, and a line of electric tapes, of which the standard brands, made of cotton sheetings and sticky rubber compound, are these: Maschemco tape, Walpole tape, Norfolk tape and Ajax tape. Among the brands made of high-grade rubber stock compounded with pure para, and devoid of cotton, are Maschemco splice and Walpole splicing compound.

THE LAGONDA MANUFACTURING COMPANY, Springfield, Ohio, recently received the following letter, which speaks for itself:

Syracuse, N. Y., Sept. 3, 1901.

Lagonda Mfg. Co., Springfield, Ohio:

Gentlemen: I borrowed one of your Weinland water-power ball-bearing cleaners from one of my neighbors a few days ago, and used the same in my boilers, cleaning 180 tubes in less than 20 hours with one set of cutters, which had already been used considerably. I was more than delighted with the work and, of course, must have a machine myself.

I have seen one of another make similar to yours, but it does not begin to compare with the Weinland.

Yours truly,

N. M. KINNEY,
Eng'r, Smith Premier Typewriter Co.

THE PITTSBURG ELECTRIC LAMP COMPANY has been incorporated for the purpose of manufacturing a new incandescent lamp, to be known to the trade as the "Pennsylvania" lamp. The company has recently completed an extensive and well-equipped factory at Braddock, Pa., near Pittsburg, and is prepared to give all orders prompt attention. The manufacture of the new lamp will not depart radically from the best modern incandescent lamp practice except that the shape of the filament will differ slightly, in order, it is stated, to give a better distribution of light. The officers of the company are L. A. Drexler, president and general manager; John J. Jennings, secretary; H. E. Kelly, treasurer.

THE AMERICAN INCANDESCENT LAMP COMPANY, York, Pa., is one of the latest to enter the incandescent-lamp field. The company has a well-equipped factory, and relies upon a perfected system of automatic machinery and the highest degree of skilled attendance to produce a lamp which will enable it to establish a sound footing with the trade. The manager of the factory has been in charge of the technical work in one of the largest lamp manufactories in the country for a considerable period, and the factory equipment will include apparatus designed by him and perfected in the American Company's experimental laboratory. The factory is being equipped for an output of 1,000 lamps per day at the start.

THE KELLOGG SWITCHBOARD & SUPPLY COMPANY, Chicago, has recently put on the market a new type of transmitter designed to meet all conditions of service. The transmitter is not only powerful, but is said to give perfect articulation. The company has so much faith in its merits that each transmitter is guaranteed for five years. A new receiver has also been put out which is smaller in size and much lighter in weight than the older instrument; the receiver also embodies improvements in electrical and mechanical design. It is claimed to be both extremely sensitive and reliable in operation, being capable of responding to the strong currents used on short central-energy lines, and to the weakest long-distance currents, with practically equal clearness.

MICA INSULATOR COMPANY, New York, announces that its selling agency in Europe, hitherto in charge of Bergtheil & Young, London, has ceased, and that an English company has been formed, named The Mica Insulator Company, Limited, for the purpose of carrying on the European business. The principal office of the new company will be at its factory at Stansted, Essex. By uniting the selling department with the factory, the company believes that business will be facilitated, by bringing it into closer touch with the market and enabling it to serve customers more promptly. The manufacture of the well and favorably-known Micanite, Empire insulating cloth and paper, and M. I. C. compound, originated by the New York company, will be continued in America as heretofore.

CHARLES E. DUSTIN COMPANY is the title of a new concern which has just been organized by Chas. E. Dustin, until recently the president and general manager of Rossiter, McGovern & Co., New York. The new company has established headquarters at the Bowling Green building, New York, and will engage in the purchase and sale of all kinds of electrical and steam apparatus and machinery, as well as the prosecution of a general electrical engineering business. Mr. Dustin, the president of the new company, was the founder of the old Schuyler Electric Company, which was eventually absorbed by the General Electric Company, and is a man of wide engineering experience and unusual executive ability, under whose direction the success of the new enterprise is practically a foregone conclusion.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, appreciating the demand for a battery of small capacity especially adapted to telegraph and fire-alarm service, has placed on the market three types of the "Chloride" accumulator, known as "B.T.," "C.T." and "P.T." cells, having a capacity of 6, 12 and 24 ampere-hours, respectively, at the eight-hour discharge rate. These types are of novel construction, the positive and negative plates having their lugs or straps cast or burned together so that the couplet, as it is termed, is shipped to the purchaser in one section, by reason of which the only labor required in setting up a battery of these elements is to insert the plates in the jars. Two plates constitute a complete element of this type, and the simplicity of installing, together with the high standard of excellence which characterizes "Chloride" accumulators in general, makes this new type highly advantageous for telegraph and fire-alarm stations.

PRATT INSTITUTE
BROOKLYN, N. Y.
TWO YEAR COURSES IN
Applied Electricity
AND IN
Steam and Machine Design
Write for Catalogue and Particulars.

SOLID TRAINS TO NORTHERN MICHIGAN.

The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

THE MASON Reducing Valves

ARE THE WORLD'S STANDARD VALVES

For automatically reducing and absolutely maintaining an even steam or air pressure.

They are adapted for every need and guaranteed to work perfectly in every instance.

Write for full information and splendid references.

THE MASON REGULATOR CO. Boston, Mass., U. S. A.

American Electrician.

Vol. XIII. New York, November, 1901. No. 11.

THE STEAM AND ELECTRIC PLANT OF A GRAPHITE FACTORY.

POWER PLANT OF THE JOSEPH DIXON CRUCIBLE COMPANY.

The works of the Joseph Dixon Crucible Company, in Jersey City, were formerly operated by four separate steam plants, located in the crucible, pencil, lead and crayon and grease and lubricant works, respectively. The plant in the crucible works developed 250 horse-power; that in the pencil works developed 80 horse-power; that in the grease and lubricant works 80 horse-power; while the plant in the lead and crayon department was capable of 50 horse-power. These subsequently gave place to the present central power plant, which distributes steam and electricity to the various buildings for heating, power and lighting purposes.

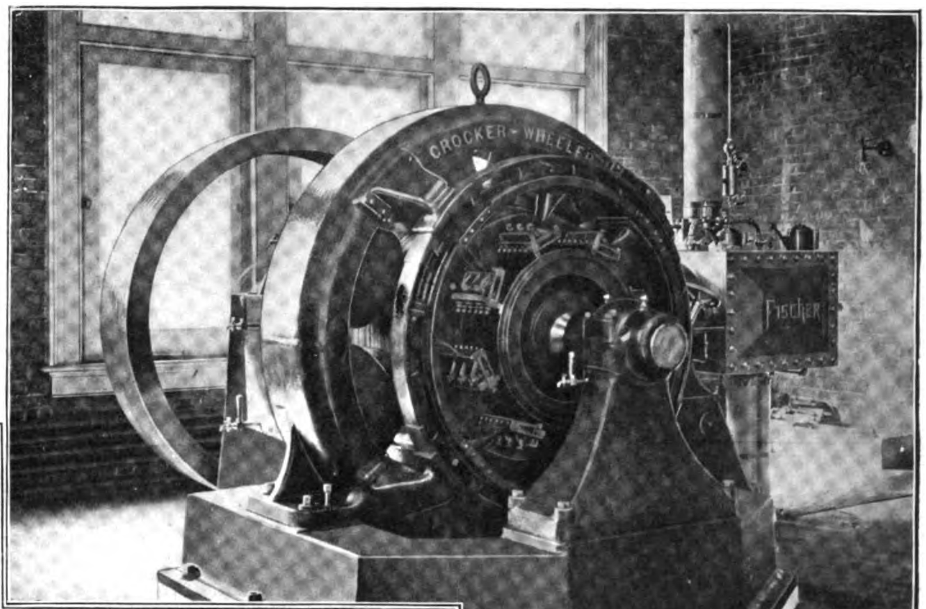


FIG 2.—MAIN ENGINE AND GENERATOR.

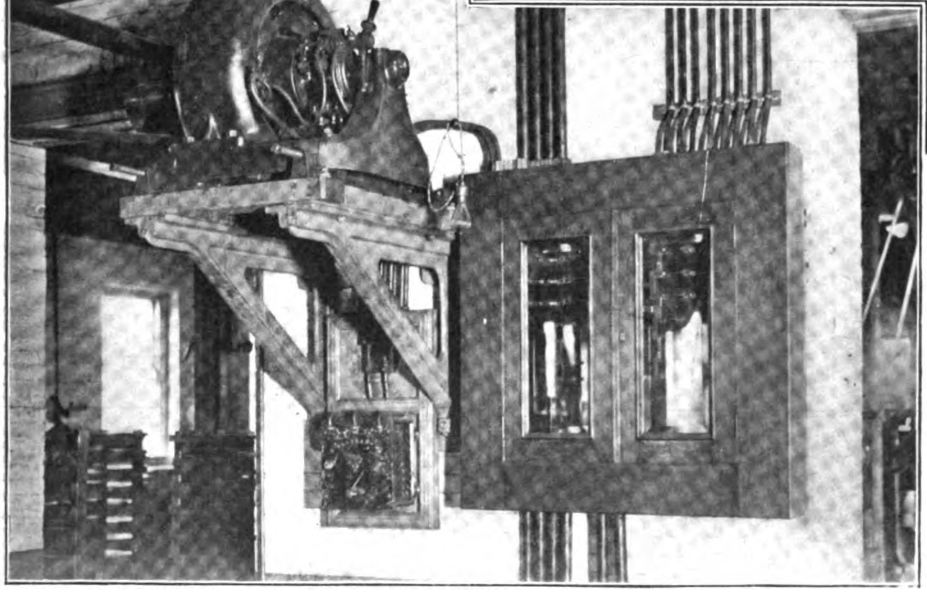


FIG. 1.—MOTOR AND PANEL BOARD IN PRESS ROOM.

The new power-house is constructed of brick, and is located directly on the tracks of the Pennsylvania Railroad. The boiler room floor is below the level of the street, and coal is dumped from carts on the floor directly in front of the boilers. Besides a 60 x 45-ft. boiler room, the house contains a 45 x 30-ft. engine room, and a pump room 20 ft. square. The chimney is of brick, and was erected by the Alphons Custodis Chimney Construction Company. It is located immediately in the rear of the boilers and has an inside diameter of 5 feet and is 150 feet high. The boiler room equipment contains a present a battery of two Babcock & Wilcox boilers, having a rated capacity of 264 horse-power each. Each boiler has two 36-in. drums 20 ft. 4 ins. long. The working steam pressure is 90 lbs. In addition to the feed pump the boilers are equipped with Korting universal injectors, which, however, are only used as a reserve. Double blow-off valves are provided and the blow-off delivers into a tank 6 ft. long and 4 ft. in diameter, open to the atmosphere and connected with a sewer. Parson hot-blast injectors (Parson Manufacturing Company, Brooklyn), are used in conjunction with Parson grates to regulate the steam pressure. The boilers are hand fired; the fuel used being buckwheat anthracite coal. Space is provided in the boiler room for an additional unit of the same size as the one already installed.

The Parson pressure-regulating apparatus referred to above is very interesting.

It is illustrated by Fig. 3, and comprises a steam damper regulator combined with forced draft apparatus. The damper regulator is of the diaphragm type, the diaphragm chamber being indicated by *A* in Fig. 3. The lever, *L*, actuated by the diaphragm or the counterweights, according to the direction of its movement, is adapted to operate a valve in the pipe, *B*, connecting the cylinder *C* with either the steam supply pipe or the waste pipe. When the steam pressure falls below the point for which the weights, *W*, are set, these weights pull the lever, *L*, down, actuating the steam valve so as to admit steam to the cylinder, *C*. A piston in this cylinder is forced downward, opening the chimney damper, *D*, wide and at the same time opening the blower valve against the pull of its loading weight. Steam is thereby admitted to a superheating pipe just beneath the steam drum of the boiler, from which it passes to the blower nozzle, *N*, in the outer end of the hot blast pipe. The inner end of this pipe delivers the air drawn in the nozzles to the ash-pit, and a part of this air is also delivered to a tuyere above the fire to facilitate the combustion of the gases. This stream passes from the hot blast pipe to the tuyere by way of a flue in the bridge wall, and is regulated by a damper in the aperture opening into the flue.

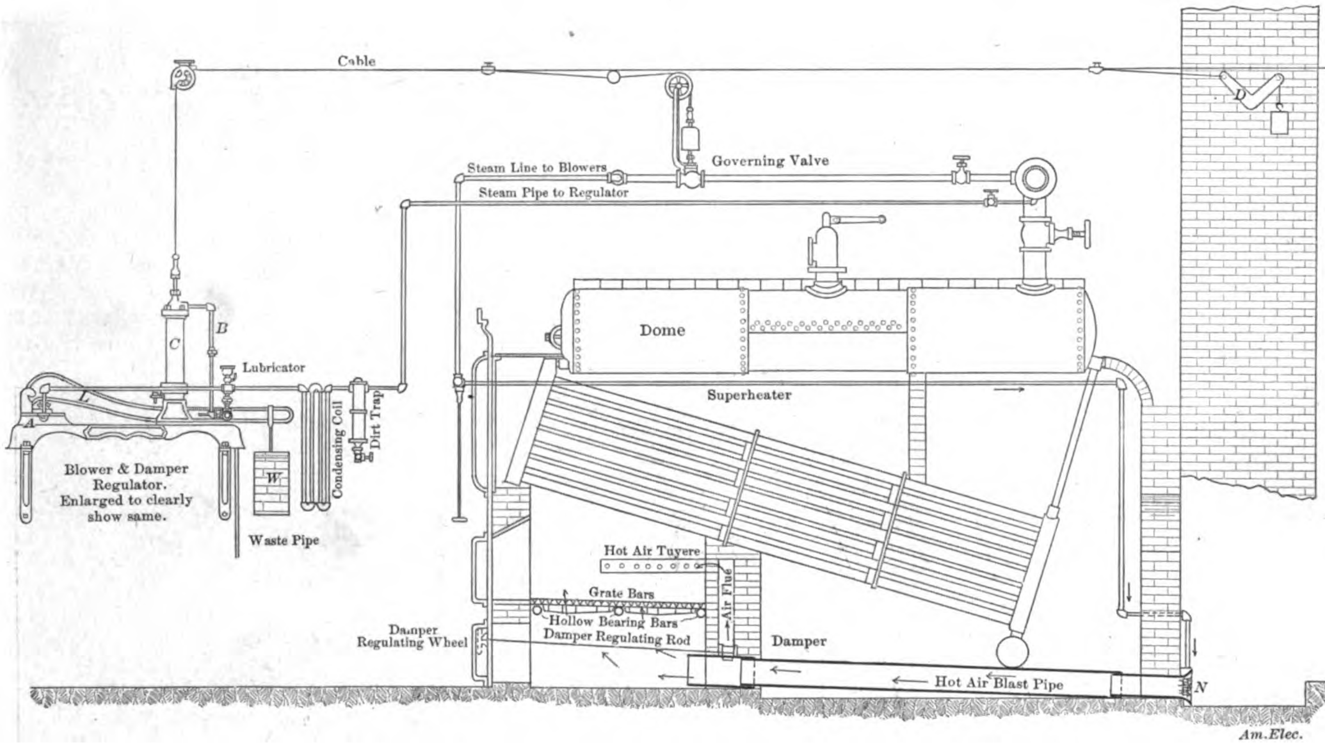


FIG. 3.—PARSON'S SYSTEM OF STEAM PRESSURE REGULATION.

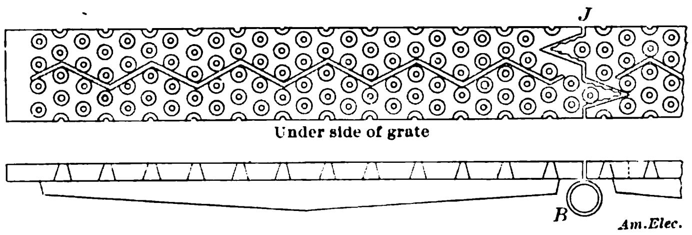


FIG. 4.—PARSON'S GRATE BAR.

The grate used with this system is not a grate at all, but a floor pierced by conical holes, the flare of which is downward. The "grate" bars, instead of being square ended and butting in the usual manner, are saw-toothed at the ends, the point of one bar fitting into the angle between two teeth on the adjacent bar, as indicated at *J* in the plan view. The stiffening ribs are zig-zagged between the rows of holes, as shown in the same view. The bearing-bars are simple cast-iron pipes, as shown at *B* in the elevation; this form is made practical by the peculiar intermeshing of the grate-bar ends. It has the advantage of shielding only a narrow band of under grate surface from the draft, covering only a part of one hole in each saw-tooth at the ends of abutting sections.

Notwithstanding the fact that the company has two artesian wells on the premises, the water is not available for boiler feed-water purposes, being too hard. Consequently the feed-water is taken from the city water mains by a 2-in. pipe, passing through an auxiliary heater to a feed-water tank in the pump pit. To this tank is also returned all of the condensation from the steam and heating mains, which is trapped by Kieley & Müller traps and delivered into the tank by gravity. From here the feed water is pumped by a 7½ x 5 x 6 Blake Duplex pump through a 500 horse-power Berryman heater (B. J. Kelly & Son, New York), to the boilers; a Kieley & Müller pump regulator being used in connection with the feed-water pump. Fig. 6 is a diagram of the feed-water connections.

In addition to furnishing steam for the direct-connected set in the engine room, the boilers furnish steam to operate Corliss engines in the crucible and grease works. These engines, however, will be displaced by electric motors so soon as the departments which they serve can be electrically equipped. Live steam is also used in some of the drying rooms, the pressure being reduced to from 10 to 40 lbs. The steam piping is fed from a 14-in. header located on top of the boilers, as shown by Fig. 5. A 10-in. feeder, reducing to 7-in., runs to the crucible works with a 5-in. condensation return. The grease works is fed with a 5-in. pipe and has a 3-in. return. A 5-in. feeder connects with the engine room, and a 3-in. feeder leads to the pump pit. All of the steam and exhaust piping is covered with magnesia lagging and laid underground The return mains run parallel with the steam mains, as the condensation, especially in the drying rooms, is very heavy. These mains connect with the feed-water tank previously mentioned.

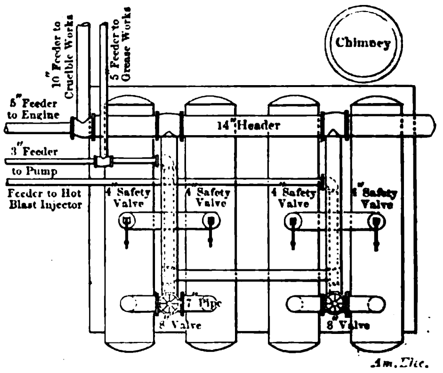


FIG. 5.—STEAM CONNECTIONS ON BOILERS.

The exhaust from the boiler-feed pump is carried to an auxiliary heater which heats the city water prior to its delivery to the feed-water tank, and then escapes to the atmosphere. The exhaust from the main engine is passed through a Kieley & Müller oil separator to a 500-h.p. Berryman feed-water heater. A back pressure valve is placed in the exhaust piping above the heater as shown in Fig. 6. In winter this valve is set at one pound, and the exhaust steam is used for heating the buildings; but in summer it is permitted to escape to the atmosphere. Should the exhaust from the boiler-feed pump be insufficient at any time to heat the city water, a part of the exhaust from the main engine is made available for this purpose by opening a valve at a point a little to the right of the tee where the engine exhaust pipe enters the exhaust main in the boiler room.

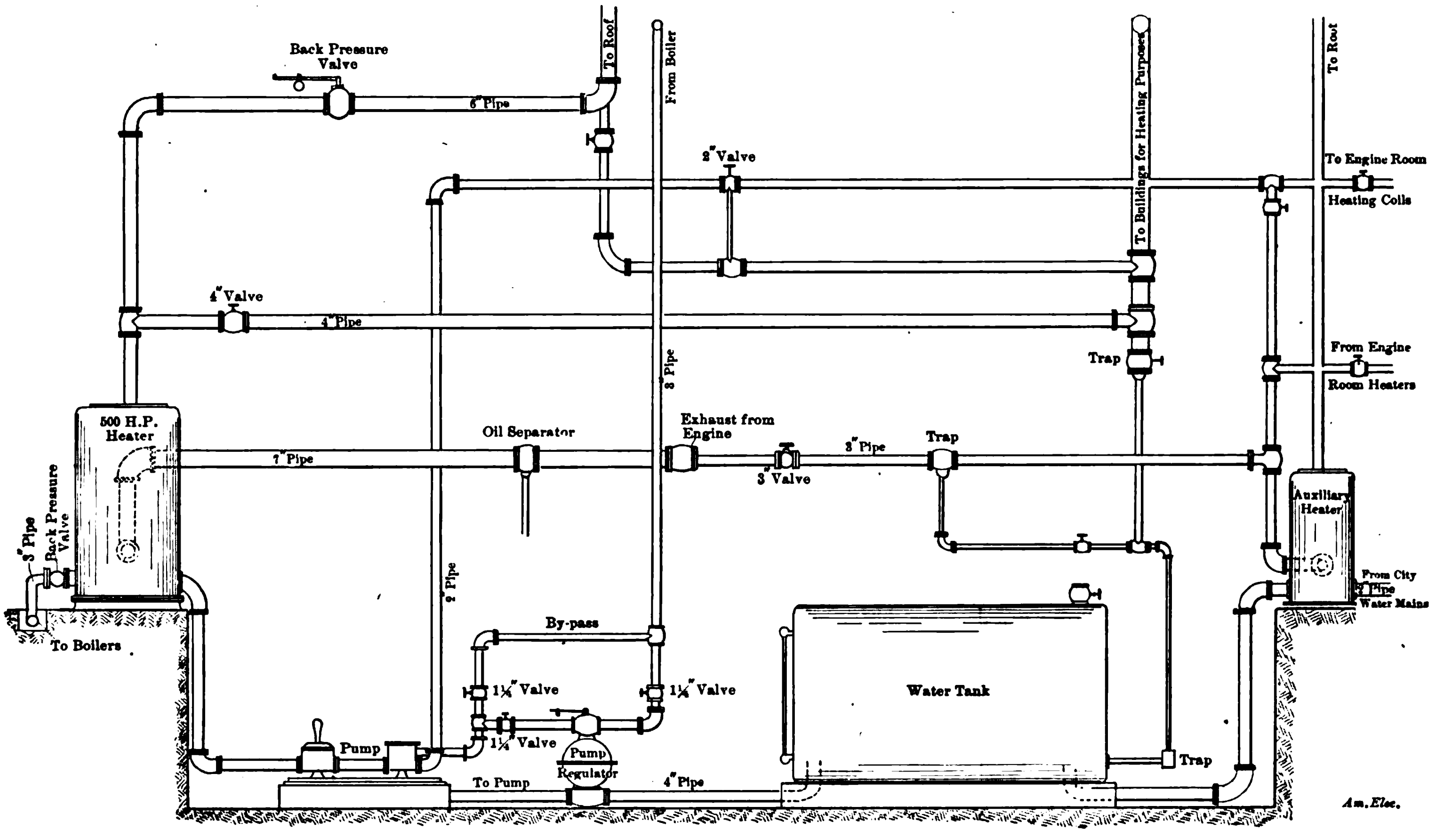


FIG. 6.—DIAGRAM OF STEAM, FEED-WATER AND EXHAUST PIPING IN PUMP PIT.

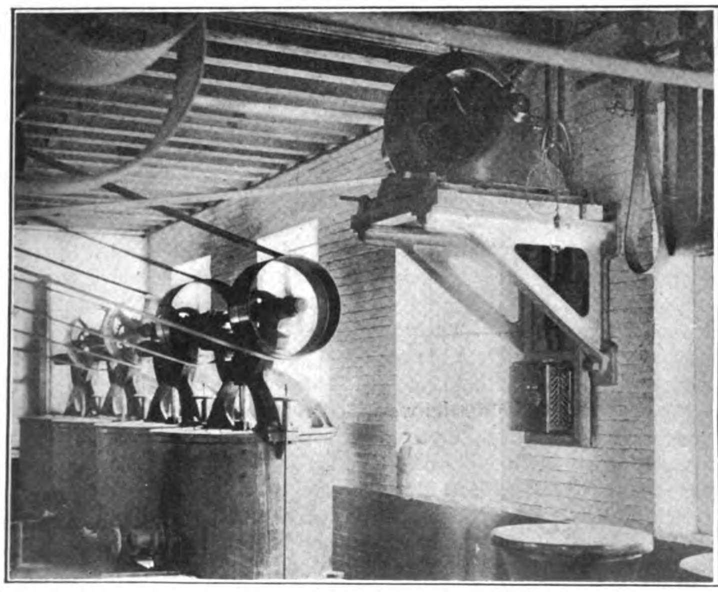


FIG. 7.—MOTORS IN MIXING ROOM.

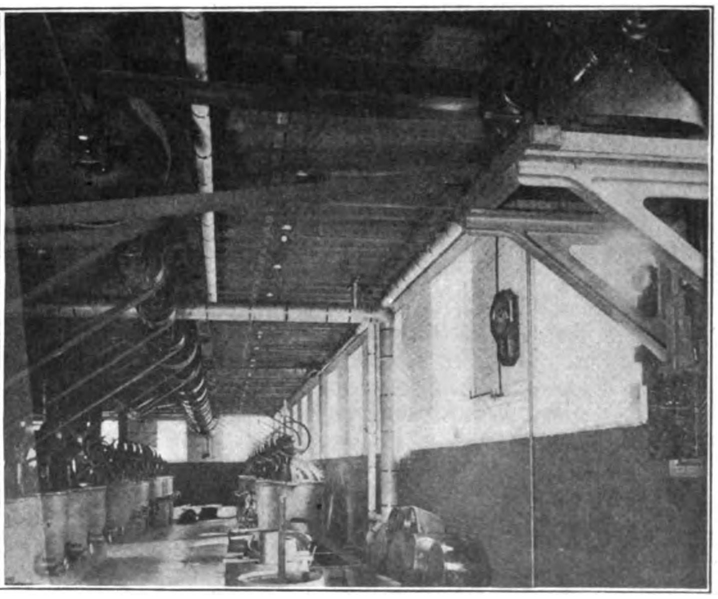


FIG. 8.—ELECTRICALLY DRIVEN MACHINERY IN BASEMENT.

The engine room at present contains a 150-h.p. Fischer simple high-speed engine, made by the Fischer Foundry & Machine Company, of Pittsburg, Pa., and direct-connected to a 100-kw. 250-volt compound-wound Crocker-Wheeler generator, which it drives at 250 r.p.m. The engine is of the enclosed four-port double-valve type with its crank turning in oil. It is fitted with the Rites type of fly-wheel governor and a Kieley & Müller separator. A gravity oiling system is used. The engine room is also equipped with a 10-ton traveling crane made from plans drawn by the company's engineer. Space is provided for three more units, which will be installed when the grease and crucible works are electrically equipped.

The switchboard is of marble, and was built by the Walker Electrical Construction Company of Philadelphia, the electrical contractors for the plant. It has the usual generator and feeder panels, equipped with Weston and Bristol instruments, I-T-E circuit-breaker, Ward Leonard rheostat and the necessary switches which connect with the various motor and lighting circuits in the different departments. The mains are carried out of the generator room in iron-armored conduit and run underground outside of the building to main distributing boards situated one in the basement of each building. From each distributing panel vertical mains run to cabinet panels (see Fig. 1) on the various floors, for sub-distribution to the power and lighting circuits, separate mains being provided for the motors and lamps. All of the buildings are lighted throughout by 230-volt incandescent lamps, so that but one voltage is required.

Fourteen Crocker-Wheeler motors are installed in the lead and crayon works, varying in size from 5 to 15 horse-power. These are belted to small lines of shafting which drive the several groups of machines. Fig. 8 shows such an application. As will be seen from Fig. 1, the motors are fastened to heavy iron brackets bolted to the walls, which gives them a rigid support and puts them in a position to least interfere with manufacturing operations. Very near and slightly to one side of each motor is a valve-closed outlet from a pipe line of compressed air, as shown by Fig. 7. The air is used to periodically blow the accumulations of graphite out of the motors. The pencil factory is being equipped with 10 Crocker-Wheeler motors of from 1 to 10 horse-power each. Aside from keeping the bus-bar voltage constant, no attempt is made at regulation, as the load is fairly constant and the drop in voltage of little consequence.

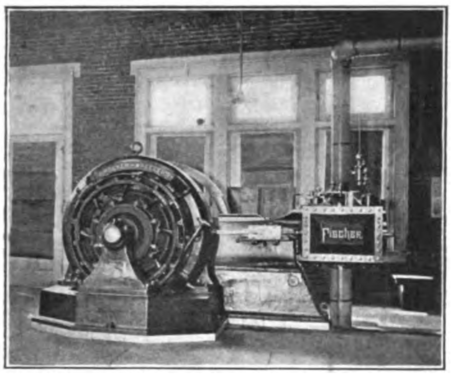


FIG. 9.—ANOTHER VIEW IN THE ENGINE ROOM

Directly back of the boiler room is the pump room, containing an Ingersoll-Sergeant air compressor and a 7 x 6 x 8 single acting Blake pump. The compressor is of the single-acting fly-wheel type, with cylinders 7 and 9 ins. by 9 ins. It is equipped with a receiver 3 ft. in diameter and 6 ft. high. The air is compressed to 100 lbs. and is used for various purposes; such as operating pumps attached to the hydraulic filters which prepare the graphite, cleaning out motors, operating an air lift used in raising the ashes from the boiler room floor to the street, and also operating the air lift for raising water from artesian wells to cisterns by the Bohle system. This consists of passing a 1-in. pipe of compressed air inside a 6-in. water pipe its entire length.

The artesian wells are 1200 and 400 ft. deep respectively. They are surmounted by cisterns of tank steel 12 x 9 x 6 ft. deep and 6 x 6 x 6; both being connected by a pipe so that the same level of water is maintained in both. From the cisterns the water is taken by the Blake pump, situated directly above the smaller cistern, for distribution through the various buildings. The exhaust steam from both the pump and air compressor is carried through a small Berryman heater situated in one corner of the pump room and thence to the atmosphere. This heater furnishes all of the hot water used in the works for manufacturing and washing purposes.

Many of the drying rooms are heated by exhaust steam, taken from the main engine exhaust. Ducts are provided in the ceilings of the drying rooms for carrying off the moisture to the roof. These ducts connect with a blower system operated by a belt-driven 60-in. Sturtevant blower situated in the basement.

Mr. Fred Engelbrecht, superintendent of the color and lead department, designed the new power plant and supervised its construction. It is to Mr. Engelbrecht's courtesy that we are indebted for the data contained in this article.

◆

NEGLECTED HEAT WASTES.

BY R. A. DOUGLASS.

The best steam engines utilize only a small fraction of the heat that is supplied to them in the steam that they use, the greater part of it going out with the exhaust. A loss of heat of this sort cannot be called a waste, however, for this particular expenditure is unavoidable in the nature of things. The "second law" of the mechanical theory of heat teaches us that in a heat motor working on any such principle as that of the steam engine it is theoretically impossible to utilize, in the production of mechanical work, more than a certain fraction of the heat that is supplied. This theoretical efficiency can be easily calculated for any given steam plant, and it is a source of considerable satisfaction to note that the performance of the best modern engines comes within a reasonable distance of this theoretical possibility.

A good deal of heat is also lost at the boiler that generates the steam, some 20 per cent or more going up the stack instead of being absorbed by the heating surfaces of the boiler. This loss is also to a large extent unavoidable. That is, there will be a considerable loss of this nature, no matter how well designed and constructed the boiler may be. Loss from this cause must therefore be placed in the same class with that indicated in the foregoing paragraph. These two are indeed losses, but they are not wastes; a waste being defined as a loss that can be avoided by proper management.

A few years ago it was very common for electric light engines to be run with a considerable back pressure, so that the puffing of the exhaust could be heard for a long distance. This kind of thing is not very common now, fortunately, for it is well understood that electric light engines can be run just as economically as engines used for any other purpose. Wastes of heat from this cause therefore do not come under the heading of this article, at the present day.

One of the heat wastes that is neglected more than it ought to be is radiation from steam piping, or from the boilers themselves. A careful test, made some years ago by Messrs. Upson and Steele, on a line of 2-in. pipe, 120 ft. long, gave results that may be studied with profit by any engineer who has naked pipes under his charge. Three tests were made, each ten hours long, and all precautions were taken to ensure that the external conditions should be the same throughout. The average temperature of the air surrounding the pipe was 70°, and was the same, within a degree or so, in all three tests. Steam was first blown through the pipe until both the pipe and the receiver attached to it were thoroughly heated up and free from water. The pipe was then left to itself with steam turned on for ten hours, after which the water of condensation was collected and weighed. The results were as follows: When the pipe was naked 862 pounds of steam were condensed, the average pressure in the pipe being 79 lbs. When the pipe was covered with "plastic material" (further description of which is not given), 480 lbs. of steam were condensed, the average steam pressure being 80 lbs. When the pipe was covered with asbestos, hair felt and paper, 222 lbs. were condensed, with the steam pressure at 77 pounds. Full particulars concerning the thicknesses of the coverings and the manner in which they were applied are not available at this writing; but it is evident that the loss of heat from the naked pipe was very large, and that the greater part of this loss could be saved by applying a non-conducting covering that was certainly not of prohibitive cost. To convert a pound of water, at (say) 180° Fahr., into a pound of steam at 79 lbs. pressure something like 1030 heat units are required. To evaporate 862 lbs. of water under like circumstances $862 \times 1030 = 887{,}860$ heat units would therefore be required; and this would correspond to a waste of about 18 tons of coal per annum—not a very large quantity, it is true, but yet a quantity well worth saving. This calculation is based on a day of ten hours. In a plant running twenty-four hours a day, the annual waste would be about 43 tons of coal. No covering would save all of this waste, of course, but, as the tests quoted above show, it is quite possible to save three-fourths of it, and very likely a larger proportion could be saved if the covering were selected with care. Almost any covering would probably pay for itself in a short time.

Radiation losses are not by any means confined to the piping, and it is not uncommon to find plants in which the piping is carefully covered, while the upper surfaces of the boilers are left bare. The loss of heat from the boiler itself is not so evident as the loss from piping, because the water of condensation merely falls back into the main body of water below, and does not force itself upon the notice of the engineer. Nevertheless, there is a considerable loss of heat from the unprotected upper surfaces of shell boilers, although the loss per square foot of exposed surface is not so great as it is apt to be in piping, because the temperature of the air immediately over the boilers is higher than it usually is around the piping. The roof and walls of the boiler house form a kind of pocket in which the hottest air of the room collects; and as it is evident that there would be no radiation at all if this air were just as hot as the boiler, so it must also be evident that the radiation from the boiler must be less, under the actual conditions, than it would be if the air over the boiler were cool. Nevertheless, the radiation from the top of an uncovered boiler must be large, and it is far better practice to provide a covering of some sort or other. The objection to a covering is that unless it is removable the boiler is not accessible on its top surface for examination. On this account coverings of sand or other similar material that are so common are not to be recommended; but a covering may easily be provided that is removable in sections of convenient size, and the radiation from the top of the boiler may be kept within reasonable limits in this manner without sacrificing accessibility.

Another common source of heat loss consists in leakages of various sorts. A leaky blow-off pipe will discharge a considerable quantity of water during a year. To illustrate, let us suppose that in a battery of boilers there is enough leakage through the blow-offs to bring the total loss of water from this cause up to the moderate amount of one quart (or, say, 2 lbs.) per minute. Assuming that the temperature of the water in the boiler is 250° above that of the unheated feed water, it is easily seen that 500 units of heat are expended every minute in heating water that is immediately discharged into the sewer. If the plant runs 24 hours a day, and 365 days a year, a very simple calculation will show that we are wasting about 15 tons of coal per annum in this very common manner. The moderate loss by leakage from the blow-off that has been adopted as the basis of this calculation is often greatly exceeded in actual practice without attracting much attention, especially when the blow-off discharges into a sewer, or other place where the drip from it would not be likely to be noticed. In fact, leakage of this sort is sometimes so serious that it forces itself upon the engineer's attention through his inability to keep the water level where it belongs, even with the pump running all the time. Steam users who are fond of mathematical exercises may find it interesting to estimate what the loss of heat would be under such circumstances as those mentioned.

Leakage from the blow-off pipe may be due to the lodgement of scale in the valve, preventing it from being properly closed, or to wear and corrosion of the valve itself. If it is due to an obstruction, it may be only temporary, because the obstruction is likely to be blown out when the valve is next opened, unless it is unusually large; but if it is due to deterioration of the valve proper it is likely to go on for a long time, because, for some reason or other, repairs to the blow-off are apt to be neglected until its condition is such that they can be put off no longer. This is all wrong; it pays to watch the blow-off pretty carefully.

Another cause of waste consists in the excessive use of the blow-off for flushing the boiler out. The blow-off cock ought to be opened once or twice every day, when the water in the boiler is quiescent —before brightening up the fire in the morning, for example, if the boiler has been lying with banked fires at night. It is impossible to give any general rule for guiding the engineer or fireman as to the quantity of water he should blow out at such times, because the character of the feed water varies greatly in different parts of the country. It may be said in general, however, that the prevailing impression appears to be that a large body of water should be blown out at such times, under all circumstances. This is certainly not a correct idea. If the water is bad, more must be blown out, of course, than would be necessary if it were good; but even when the water is soft and comparatively free from scale forming matter, it is by no means uncommon for the engineer to fill the boiler up and then blow down 3 or 4 ins. As has been said, no general rule can be given as to this particular point; but when the water is fairly good any such quantity as has been indicated above is excessive. Usually it will be sufficient to open the cock wide until the blow-pipe is thoroughly flushed out; and any blowing that is done after this may be regarded as excessive and wasteful of heat. If a quantitative estimate of the loss from this cause is desired, it may be said in a general way that engineers not infrequently waste from five to ten tons of coal per annum per boiler, by too liberal blowing off.

Leakage of steam around fittings and through the safety valve is another important cause of loss, and the magnitude of this particular loss is often surprising to those who have not figured over it. To illustrate, suppose that there is a leak around a pipe fitting that is 1 in. long and 1/100 in. wide, the total area of cross section (or discharge area) of the leak being, therefore, 0.01 sq. in. Next, suppose that the pressure within the pipe is 90 lbs. above the atmosphere. Then it is easily found, by the aid of the usual formulas for the flow of steam through orifices of this sort (Napier's, for example), that under the circumstances here assumed the discharge of steam through the tiny orifice mentioned will amount to no less than 54 lbs. an hour. This loss, continuing for 24 hours a day, and for 365 days a year, would call for the consumption of approximately 30 tons of coal a year. It is evident, therefore, that steam leaks, even though they are very small, should be looked after very sharply. It is not at all uncommon, even in plants that are run upon a good, sound basis in most respects, to see much more coal wasted through small steam leaks than the 30 tons that correspond to the particular example selected for the purpose of illustration.

THE RELATION OF THE RATE OF EVAPORATION TO THE FUEL ECONOMY OF BOILERS.

BY WILLIAM D. ENNIS.

That the rate at which water is evaporated in a boiler is a potent factor in the fuel economy shown by the performance of the boiler has long been recognized, but authorities do not agree as to what the relation between the two is, nor indeed as to whether a given type of boiler should be worked at the same rate of evaporation for maximum fuel economy under all conditions or not. A well-known engineer has for some time been endeavoring to prove that there is a most economical rate of combustion per square foot of grate surface for a standard type of boiler and fuel. Still another eminent authority has made tests showing for one horizontal tubular boiler that the best evaporative effect was obtained when it was driven to nearly twice its normal capacity. The present writer has made tests on horizontal tubular boilers showing a decrease of fuel economy when the rate of evaporation was made greater or less than 80 per cent of the rate fixed by the common standard of rating. In another recent test the writer found it economical in a boiler plant that was heavily overloaded to increase the overload by dropping out one of a battery of 10 boilers.

From the data of these last results, it appears that in some cases the most economical rate of evaporation is about 80 per cent of the boiler capacity, figured according to the standard method, and that loading beyond this point causes a decrease in fuel efficiency until an overload of about 50 per cent is reached, when there is apparently a slight gain at any further overload. As the rating in square feet of heating surface per horse-power ought to be a fair comparison between horizontal tubular boilers of about the same size, there is a flaw somewhere in the existing analysis of the economical rate of evaporation.

The only way to determine positively the best rate of steaming for a given battery of boilers is to make a number of tests at various rates of evaporation and with the quality of coal that must be used, comparing carefully the fuel consumption per unit rate of evaporation in each case. Where more than one kind of fuel is obtainable, a complete set of tests at different rates of steaming should be made with each kind of fuel and the results compared.

◆

RELATIVE MERITS OF OPEN AND ENCLOSED ARC LIGHTS FOR STREET ILLUMINATION.

BY W. D'A RYAN.

There are several ways of expressing the candle-power of an arc lamp. Some take the average of the light thrown in all directions, namely, the mean-spherical candle-power; others the average of the light in the lower hemisphere, which is the mean-hemispherical candle-power; others the average of light over a selected number of degrees, such, for example, as from the horizontal to 60° below. Then, again, the average of the maximum readings, or minimum readings, or the mean average of all readings, may be used, but the maximum candle-power of an arc lamp is the value usually referred to, notwithstanding the fact that this actually means less, as far as the value of the light is concerned, than any other comparison which might be employed. Of course, it is well known that the so-called 2000-c.p. direct-current open-arc lamp, taking about 10 amperes at 48 volts, does not give the candle-power for which it is nominally rated. The average maximum candle-power is about 1250, taken at an angle of 45° (by "average maximum" is meant the average of several readings of the maximum candle-power, which is usually given at the angle specified).

Fig. 2 is plotted from the average of a number of measurements of maximum candle-power taken with different lamps equipped as they should be in commercial service—that is, with the proper globes, reflectors, etc. Fig. 1 is a set of curves showing the street illumination of different types of lamps, the curve *A* being plotted from measurements taken with a direct-current open arc, the curve *B* from a direct-current enclosed arc, and the curve *C* from an alternating-current enclosed arc. An analysis of the candle-power curves of Fig. 2 will show that all candle-power ratings, either maximum, mean-spherical, or averages through any selected angle, are of little service in determining the commercial illuminating value of different lamps. The street illumination curves of Fig. 1 are more satisfactory. These curves show the intensity of illumination which will fall upon objects on the street normal to the rays of light at different distances from the base of the pole, the range being carried to a point midway between lamps 300 ft. apart, where the rays from neighboring lamps intersect.

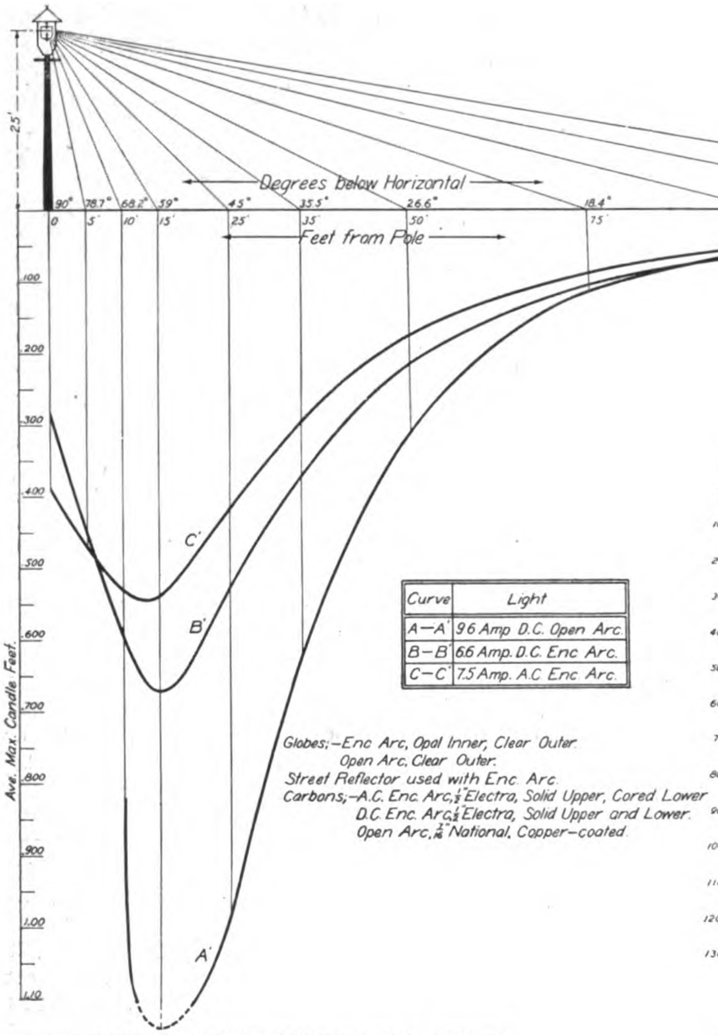


FIG. 1.—STREET ILLUMINATION CURVES.

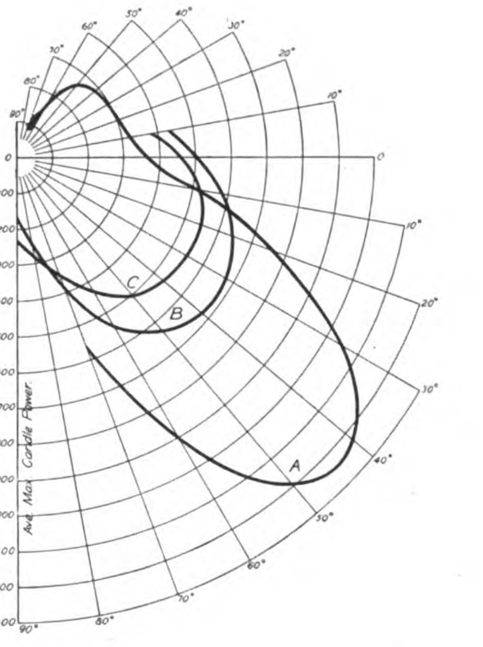


FIG. 2.—CANDLE-POWER CURVES.

INHERENT PECULIARITIES OF DIFFERENT LAMPS.

The 10-ampere open-arc lamp burns with a very short arc, approximately ⅛ in. long. About 10 per cent of the total light comes directly from the arc, 5 per cent from the heated carbon tips, and the remaining 85 per cent is emitted by the crater in the ends of the positive carbon. The intensity of light in any given direction is therefore approximately proportional to the amount of crater surface visible from that direction. When the arc is in the center of the carbons and burns normally, the largest portion of the crater is visible at an angle of 45 degrees, so that the maximum candle-power is obtained in this direction, as previously stated. At 70° below the horizontal the lower carbon practically intersects all the light from the crater, throwing a shadow on the ground immediately below the lamp.

In contrast to this, the enclosed-arc lamp has a long arc burning in a space which is practically free from oxygen; although most of the light comes from the crater, still a greater percentage is emitted directly by the arc itself, owing to its length. A large portion of the crater area is visible over a wider vertical angle and the crater is not so concave as in the open arc, so that there is less concentration and a better distribution of light. Figs. 3 and 4 illustrate the difference between the forms assumed by the carbons.

In open-arc lamps two distinct variations in the light are constantly taking place, one due to the increase in the length of the arc between the time it is struck and the time of the first feeding action, and the other due to the wandering of the arc on account of the non-homogeneity of the carbons and drafts of wind. In enclosed-arc lamps there is very little change in the length of the arc at any time. Fig. 5 illustrates the changes in the length of the arc and consequent increase in the light emitted, as shown by an open arc, and Fig. 6 illustrates the performance of an enclosed arc. The principal variation of the light emitted by an enclosed arc is caused by the travel of the arc over the almost flat carbon ends. When the arc is in the center of the carbon there are equal lobes of light on each side, and when it travels to the edge the lobe of light on that side becomes enlarged, while the lobe on the opposite side is reduced Notwithstanding this, the mean-spherical candle-power of the lamp remains practically constant at all times. Furthermore, the variation in the illuminating effect can be greatly reduced by the use of an opal enclosing globe; even if a clear enclosing globe is used the shadows caused by an enclosed arc will not be so strong as those of the open arc.

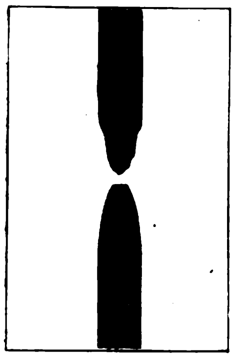


FIG. 3.

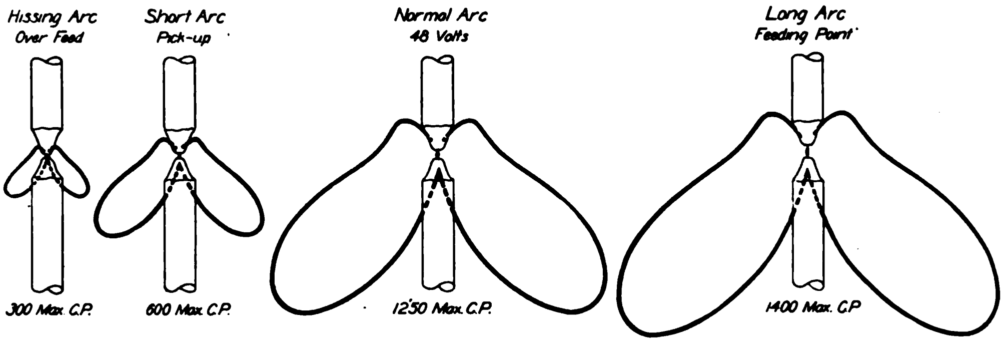


FIG. 5 —CANDLE-POWER CURVES FROM OPEN ARC.

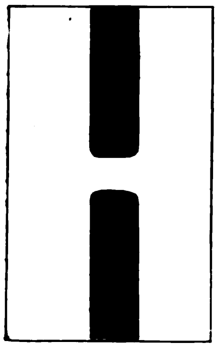


FIG. 4

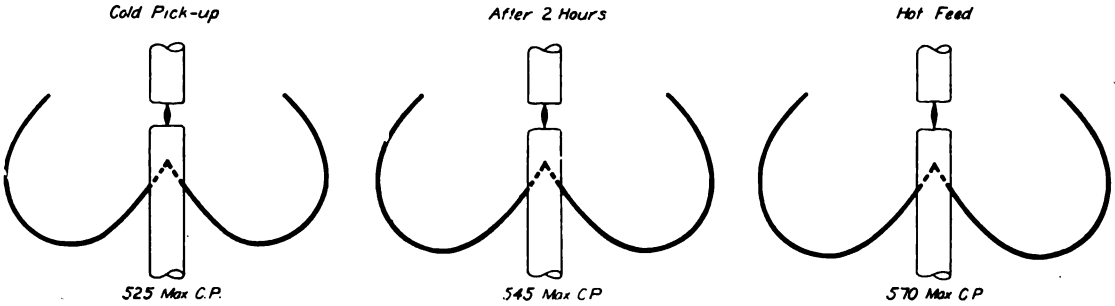


FIG. 6.—CANDLE-POWER CURVES FROM ENCLOSED ARC.

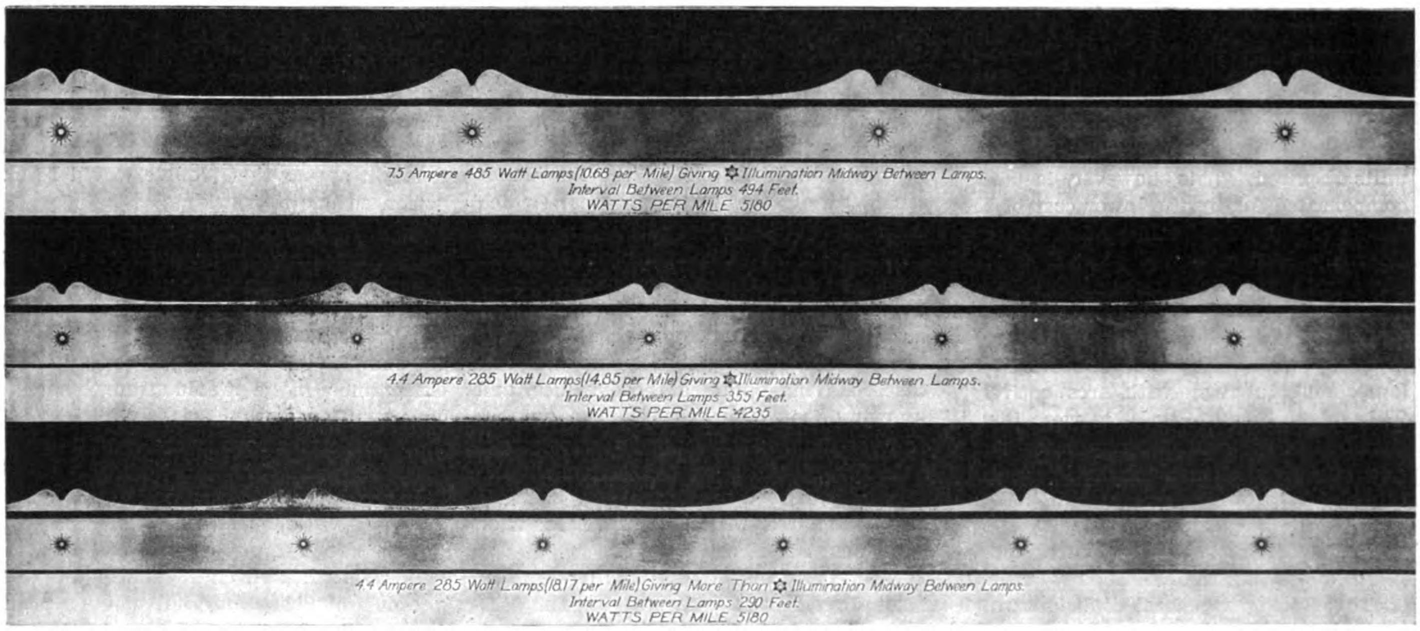


FIG. 7.—CURVES SHOWING STREET ILLUMINATION FROM ENCLOSED ARC LAMPS.

The characteristics of the direct-current open and enclosed arcs may be summed up as follows: With an open arc, the mean-spherical candle-power and the power (watts) required at the arc are different at different intervals of time between the picking up and the feeding points; the fluctuation of light due to the wandering of the arc is very marked, also the flickering due to the wind and non-homogeneity of the carbons; dense shadows are caused by the lower carbons and side rods, and the intensity of light in the immediate vicinity of the pole is objectionably strong, while the light at points midway between poles varies between wide limits. With the enclosed arc, the mean spherical candle-power and the watts at the arc remain practically constant at all times; there are no shadows caused by the carbons or the side-rods, and the light in the vicinity of the lamp is subdued, while the average light midway between lamps is somewhat stronger than that from the open arc and is not subject to so wide a variation

DIRECT-CURRENT *vs.* ALTERNATING-CURRENT ENCLOSED ARCS.

The candle-power curves of Fig. 2 show that the direct-current lamp gives slightly more light than the alternating, and the illumination curves of Fig. 1 also show that the direct-current lamp gives more light at the point midway between poles. The difference here is not so great, however, but that it might be nearly, if not entirely, compensated for by the better distribution of light from the alternating arc, the latter having a more subdued light in its immediate vicinity, which increases the relative effect of the light at a distance by reducing the contrast. Carrying efficiencies back to the generator shaft would in many cases throw the balance in favor of the alternating-current arc, but the efficiencies of different plants are so greatly modified by local conditions that the watts at the lamp terminals form a more satisfactory basis of comparison.

SMALL *vs.* LARGE UNITS.

The number of lamps per mile is governed to a great extent by established locations, distance between cross streets, and other local conditions. Nevertheless, the greater economy and superior illuminating value of small units are well worth considering. While with a constant voltage at the arc the candle-power increases in proportion somewhat more rapidly than the watts, the lighting distance increases only as the square root of the candle-power. It is therefore more economical to work with a lower-efficiency arc at a short distance than with a higher-efficiency arc at a long distance. Of course, this argument does not apply to interior lighting, where distances enter far less into consideration.

A series of tests made with alternating-current enclosed arcs in four units, namely, 7.5 amperes (485 watts), 6.6 amperes (425 watts), 5.4 amperes (350 watts), and 4.4 amperes (285 watts), showed that the distance to which these units will project a given illumination (a certain standard having been established with a luminometer) is 247, 227, 197 and 178 ft. respectively, with a corresponding power consumption of 5180, 4940, 4690 and 4235 watts per mile, respectively. This test showed a saving in favor of the 4.4-ampere lamp of 945 watts per mile as compared with the 7.5-ampere lamp for the same illumination midway between lamps, and with the advantage of three additional brightly illuminated areas per mile of street. This comparison is graphically shown by Fig. 7. The 7.5, 6.6 and 5.4-ampere lamps were equipped with ½-in. carbons, while the 4.4-ampere lamp was equipped with 7/16-in. carbons. This accounts for the longer minimum luminometer distance of the small unit.

While the small unit will illuminate a greater distance per watt of power consumption, this advantage is somewhat offset by the increased initial cost and maintenance per mile for the additional small units required. This, however, is partly compensated for by the lower cost of the smaller-size carbons, and as there is considerably less energy dissipated in the globe, a longer life is natural to this accessory. Following this line of reasoning, one might ask why not carry the argument for small units down to incandescent lamps and do away with arcs entirely? This might be quite possible were it not that one of the essential requirements of good lighting is that the buildings and other objects on the street shall be illuminated to a considerable height above the ground. Arc lamps fulfil this requirement by flooding the buildings with light, thus producing a general diffusion which gives the street an illuminated appearance that cannot be obtained with incandescent lamps unless they are placed very high and at such short intervals as to make their use prohibitive from the standpoint of cost. Furthermore, the light from incandescent lamps, in common with that from all other comparatively low-temperature sources, lacks the brilliancy obtainable from the arc.

[The foregoing is an abstract of a paper read before the Ohio Electric Light Association at Put-in-Bay.]

◆

IMPROVISED BOOSTERS.

BY WALTER M. HOLLIS.

It is safe to say that at some period of the growth of nearly all the smaller electric railways it has been found on extending some of the longer lines that trouble was experienced in operating the cars upon the regular schedule. The report from the motormen may be simply that they were unable to make time because the car would not speed up, or a more serious turn may be given to the matter by the condition of the motors. The inspector may discover motors badly overheated and charred, or, what is very likely to be the case, motors may burn out on the road with unusual frequency. This may occur when cars are operated on the regular schedule, or may not appear until some special occasion calls a larger number of cars into use near the end of the line.

Upon investigation it is usually discovered that the trouble is due to low voltage caused by excessive drop in the line. The next thing to do is to see what the drop really is. By keeping the station voltage as steady as possible for a time and running a car provided with a voltmeter connected between trolley and ground, at the end of the line, the difference in voltage is speedily found. In order to get a complete and exact knowledge of the conditions, it will be well to try this under various conditions, that is, with one car started slowly and then quickly, and then with several cars together in such combinations as are likely to occur in practice.

At this time (if the figures are not already at hand) tests should be made to determine what current the cars will take at normal voltage, under the conditions likely to obtain at the end of the line under consideration; that is, supply a car (which is in good condition) with a voltmeter and an ammeter and take readings at normal voltages while the car is run under similar conditions as to track and grades to those on the line. This, of course, is a rather rough method, but it will serve in this case. Having obtained these values, and knowing from the schedule the number and positions of the cars at various points at different times on this extended section, a very good prediction may be made as to the current necessary for these cars, at or near normal voltage.

Now, in a case like this there are at least three resources for solving the difficulty (an additional station, storage batteries, or alternating transmission being out of the question). First, additional feeder wire; second, a booster in the present feeders; third, a combination of these two. The scope of the present article is not great enough to include the many questions which decide, under given conditions, whether or not a booster shall be installed; it is assumed herein that the conditions are such that a booster is the best way out of the difficulty. The third method, then, will be discussed—the use of a booster and an additional feeder.

Assume that the particular branch under consideration extends from the station for a distance of about nine miles, and the heaviest load is well out toward the end; suppose that this load amounts to about 150 amperes at its maximum. (This 150 amperes is calculated from the values known to be used by cars under the given conditions at normal voltage, combined with a study of the schedule, which latter shows the positions of the cars at any particular time and place.) Suppose that a further study of the conditions, including the allowable cost of additional feeder wire, shows that a drop of about 300 volts, with 150 amperes flowing, is the value to be used. As this 150 amperes is a maximum value for regular running conditions, and not the average value, the actual all-day loss in the line is not so great as might appear at first sight. With 550 volts at the station and a drop in the line of 300 volts, a "boost" of 300 volts will obviously be required to give 550 volts at the end of the feeder. A "boost" of 300 volts, with 150 amperes flowing, means a booster ratio of 2 to 1.

Consider somewhat in detail the conditions under which a series booster operates. The entire feeder current flows through the field as well as the armature, and supplies the entire field excitation. The current in the feeder, and consequently in the field, varies beteen zero and 150 amperes. Now, so long as we keep below the bend in the excitation curve, or before the field magnet core becomes saturated, the ratio of field strength to amperes, and hence of volts to amperes, remains constant. This, however, is not of strict importance, so long as we know about what to expect and do not go too far beyond. As is easily seen, this means a field range from about zero nearly to saturation, and it might appear that trouble would be experienced due to sparking, etc.

In designing a shunt or a compound-wound machine, the question of sparking depends upon: the volts per commutator bar, the field strength, the armature reactive ampere-turns, and the inductance of the short-circuited armature coils; in such a machine a range of field strength such as that mentioned would clearly be impossible. In a series booster the conditions are something like this: Starting with a 300-volt "boost" at 150 amperes, the machine runs all right, sparklessly. If, now, the current drops to one-half, 75 amperes, the field strength, and consequently the voltage of the "boost," are halved. This cuts in two the volts per commutator bar, so that the field is now able to reverse the current in the armature coils between adjacent commutator bars under precisely similar conditions as heretofore. This is the case all the way up and down the voltage variation.

As the field and armature are in series, the armature back ampere-turns that react upon the field vary in just the same proportion as the field ampere-turns, and there is at all times, within the limits set, a balance of forces. In the case of a very sudden increase of current there will be a tendency toward sparking, more especially if the field poles and cores are massive, as then there is likely to be some sluggishness in the change in the field strength and for a moment the armature reaction may weaken the field and so cause sparking.

At the present time boosters of all sorts, kinds and descriptions may be bought ready made, or made to order for a consideration, but this was not always so, and even now an improvised booster may be made up that will give entire satisfaction and cost less. Some stations may be so fortunate as to have an old-style smooth-core or gramme-ring generator, already operating with newer machines or kept as a spare, as is the case in many installations. Now, a machine of this type can be very readily and economically changed into a booster. It is safe to say that the machine is belt-driven. For this particular case a machine of about 40 to 50 kilowatts capacity will be required. The following points must be ascertained at the outset: (1) Turns on each field spool (ascertained from the manufacturer or by actual count); (2) ampere-turns of field at full load (field current multiplied by turns); (3) ampere-turns of field which give the bend in the saturation curve. In order to ascertain the field ampere-turns required at the point where the saturation curve bends most sharply, proceed as follows:

Run the machine at normal speed with the armature open-circuited, and measure the volts at the brushes and the amperes in the field. Start with a strong field, decreasing gradually and taking readings at intervals on the instruments until a low reading is reached. Then break the field entirely and start in again with a weak field, gradually increasing and taking readings as before, until the preceding high values are reached. If these values are plotted with armature volts vertically and field ampere-turns horizontally, the bend in the curve, or the point where the field approaches saturation, is very easily seen. Care should be taken when decreasing the field strength to keep going down and never return to a point, and *vice versa* when coming up the curve. The curves will doubtless come fairly near together and a mean value can be taken. The ampere-turns corresponding with the bend of the curve should be taken as the maximum value of the field ampere-turns in rewinding the booster, although a large leeway is allowable if by that means it will be better for the other factors, as for instance the winding of the armature. In this particular case the value of the ampere-turns obtained from the curve, divided by 150, will give the number of turns for each pole of the booster.

Next ascertain (4) the armature turns in series between brushes (obtain from manufacture or by inspection); (5) normal revolutions per minute (probably on name plate); (6) maximum allowable brush contact on commutator (by inspection; the increased current will doubtless require more brush bearing-surface, and even if a commutator of the same number of segments is used greater width will be necessary. A new commutator may be required).

In the case assumed, if the other conditions are favorable (as will be discussed later), the turns on the armature in series will be for the booster about 300/500 of what they were before, the machine having been originally wound for 500 volts. There are so many types of machines which might be adapted in this way that only general advice can be given; but in many cases the entire work can be performed by a regular employee, although a skilled armature winder will be required. The voltage of a dynamo depends upon the speed, S; the strength of the field, F; and the turns in series on the armature. By varying any of these quantities we vary the voltage, or the "boost" in this case, by a proportional amount. So that here, within considerable limits, the speed of the machine may be varied and this may help out in the armature winding. That is to say, the maximum strength of the field is fixed by the original design of the machine; the maximum volts "boost" is fixed by the conditions first determined; hence, the product of r.p.m. and turns in series on the armature must equal a certain value. They may, however, be varied between themselves, which may give some leeway in winding the armature. Below the field maximum there is also a considerable range, and all of the above quantities can be varied (subject to the above conditions) to favor the winding of the armature.

The rewinding of the field is very easily done; the coils may be of copper ribbon or simply flexible cable coiled on, depending, of course, upon the machine. If a flexible cable is used, a rough way of getting the proper field would be to simply wind on what is known from previous tests to be an excessive number of turns and then measure the "boost" with full load on the machine. Turns could then be taken off until the proper voltage was obtained. This applies more particularly to a bipolar machine where the cable could be easily handled.

It sometimes happens after a booster is installed, that a change is required in the ratio of volts to amperes. There may be a change in the regular load conditions on the feeder, or it may be desired to switch the booster to some other feeder. Within certain limits this is easily accomplished, if the desire is to lessen this ratio, by putting a resistance in parallel with the field, shunting part of the current. It will be found very convenient to have this shunt box made up with several steps in it, so that a change of ratio can be very readily obtained.

Knowing the field resistance, the present maximum ampere-turns on the field, and the corresponding maximum volts "boost" and amperes, the resistance for the shunt box can be easily calculated.

The first ratio is $\dfrac{300\text{ volts}}{150\text{ amperes}} = 2$; say the desired ratio is $\dfrac{200\text{ volts}}{150\text{ amperes}} = 1.33$.

Now, as shown above, the volts supplied by the booster depend directly upon the field strength or ampere-turns, other things being constant. So we reduce the ampere-turns on the field according to the above ratio. If the first ampere-turns are represented by A, then the second ampere-turns will be equal to $A \times \dfrac{1.33}{2.00} = 2/3\,A$, and if the field resistance be represented by R then the shunt box resistance will be equal to $2R$, according to the principle of divided circuits.

As shown above, if this weakens the field too much, so as to entail sparking, a lowering of the speed may be resorted to instead. It should be kept clearly in mind that nearly all the essential points have considerable allowable margins on both sides. These limits can be determined by experiment and observed in changing the machine. In rewinding the armature a liberal policy should be followed as to radiating surface and size of wire for the increased current.

◆

SOME EXPERIENCES AND RESULTS DERIVED FROM THE USE OF HIGHLY SUPERHEATED STEAM IN ENGINES.

BY R. LENKE.

The behavior of superheated steam is similar to that of gases; it is a very bad conductor of heat, and has the special peculiarity of being able to lose a certain amount of heat without becoming saturated or wet steam. The thermal capacity of steam is only 0.48, therefore very little heat is required to superheat it; but as the steam loses the heat as quickly as it acquires it, every passage conveying superheated steam must be well covered with non-conducting material. Although there are some losses when using superheated steam on account of the heat radiation, they are very much smaller, because the loss of heat from superheated steam has lower calorific value than the latent heat of saturated steam.

Superheated steam has a greater volume per unit of weight than saturated steam at the same pressure, hence one advantage, and the higher the temperature the greater this advantage. At various pressures and temperatures the increase of volume may be taken from Table I. This table shows that the higher the pressure is, the smaller the increase

TABLE I.

Pressure.	390° F.	570° F.	750° F.
70	1.1	1.33	1.57
115	1.06	1.29	1.52
170	1.02	1.24	1.46

of volume; and it is proved from practice that the advantage with lower pressure is indeed greater in proportion than with higher pressures.

The question may arise whether the increase of volume does not require more additional heat than the benefit derived from it is worth. To show this clearly Table II has been prepared, expressing the B. T. U. required to produce 1 cu. ft. of superheated steam at different temperatures, and 1 cu. ft. of saturated steam at the same pressure.

TABLE II.

Steam press.	B. T. U. required to produce 1 cu. ft. of saturated steam.	B. T. U. required to produce 1 cu. ft. of superheated steam at:		
		390°	570°	750°F.
70	233	219	192	175
115	350	337	297	267
170	492	485	432	398

In engines using saturated steam, 20 to 25 per cent of the admitted steam is condensed during the period of admission; consequently the practical steam consumption is very much in excess of the theoretical value. To obtain the full benefit from superheated steam the temperature required is 660 to 700° F., and in order to stand this temperature the engine must be specially designed. The introduction of superheated steam into engines largely influences the expansion of the superheated parts.

In experiments by the writer, engines always gave great trouble when the distribution of metal in the cylinders was not uniform, as parts with more metal expanded most, and forced the cylinder walls toward the inside, putting the cylinder out of shape. When using liners in the cylinders they are squeezed in at the ends, decreasing the diameter, and jamming the piston body if sufficient clearance was not provided. With steam jackets heated with steam of 500° F., the lubrication ceased as the cylinder walls became too much heated; consequently it was found necessary to do away with jackets, or, if jackets were already provided, not to pass steam through them. Pistons constructed on the Ramsbottom type always worked satisfactorily, except in the case of pistons fitted with steel springs, when they were in contact with highly superheated steam. Any kind of gun metal gets brittle after a very short time, therefore valves, seats, and all parts in direct contact with superheated steam, must be made of cast iron or other suitable mixture. Copper also loses about 40 per cent of its strength at that temperature, consequently copper bends in pipes are not practicable. The best material for piping has proved to be wrought iron and steel, each pipe being as long as possible, to have the least number of flanges. For long, straight pipe connections provision must be made to meet the expansion, which is at 700° F., 0.0037 of the length; so that, for example, 100 ft. of pipe extends 0.37 of a foot, or nearly 4½ ins.

Glands and stuffing boxes at first frightened users, so the engines were constructed single-acting to avoid the use of glands, but no serious difficulties have arisen on that account. It is advisable to place the stuffing box as far as possible from the cylinder end, to keep it well away from the hottest parts and to allow of as much radiation as possible. Sufficient clearance in the neck bush should be made to allow for the expansion of piston rod, and no metal with a melting temperature below that of the steam should be used.

Valves and valve gears are influenced in the same way by superheated steam. Valves containing many ribs or different thicknesses of metal (in section), such as plain slide valves or Corliss valves of the usual construction, are not suitable for high temperatures. A Corliss valve of medium size will stand 480 to 500° F., but no more, and the latter temperature very seldom. The smaller the plain slide valves are, the higher temperature they will stand; large slide valves will hardly stand even slightly superheated steam, if no provision is made for forced lubrication of the valve face.

Piston valves have proved to be most suitable for the highest temperature, owing to their uniform distribution of metal, but even with this sort of valve certain experience is necessary to get them in good working order. With ground valves the ribs holding the boss for the valve spindle must not begin within the working surface of the valve, but have to be placed beyond that, because they expand and make the valve polygonal. The valves must be ground in other liners than those in which they are to work in the engine; the former liners have to be smaller in diameter to secure more clearance, so as to provide for the expansion of the valves. The cylinder expands in length more or less than the steam chest, causing thereby deformation of the latter, which must be carefully considered in design.

It is best to work the valves in liners fixed in the cylinder with a small clearance, sufficient to allow for the deformation of the steam chest. With this construction it is, of course, necessary to make steam-tight joints between the several ports, and this is best done by stepping the liners and seats and using narrow asbestos rings for each step. The liner is then forced on to the small seats by set-screws in the cover, these asbestos rings making a lasting joint. Long valves cast in one piece become scored, whether they are cooled from inside with exhaust steam or not; consequently all valves should be as short as possible. Rings and springs in valves cannot be recommended, as the steam comes behind the rings and increases the pressure, causing friction. As it is impossible to rely on tightness of piston valves, they must be made as small in diameter as possible. It may be stated here that superheated steam can travel at 30 to 40 per cent higher speed through steam ports than saturated steam, and this fact has to be considered.

Two piston valves working one in the other, as the Rider or Meyer valves, are impracticable for superheated steam. If engines of that type are intended to be worked with superheated steam, each valve must work in a separate chamber.

Double-beat valves can also be recommended as being safe, but they require a special arrangement, which is not always obtainable with every gear. Very often it happens, when warming up the engines, that the valve spindles get hotter than the gland boxes, and on starting the engine the friction between spindle and stuffing box is greater than the power of the spring, and if the valves are not positively driven, they remain open during the full stroke.

An engine constructed in accordance with the principles just explained is as safe with superheated steam as any other engine with saturated steam. Judging from an experience extending over several years, it is not necessary to be bound to single-acting engines.

Besides the economy, the use of highly superheated steam has some other advantages which are also important. It makes the steam consumption nearly independent of the size of engine, as a small engine has about the same steam consumption as a large one, as for example: An 80-h.p. compound-condensing engine uses 10.45 lbs. of steam at 160 lbs. pressure, and a 1000-h.p. engine uses 9 lbs. of steam per indicated horse-power per hour. The use of highly superheated steam does not require high boiler pressures; 160 lbs. is the highest to be recommended, as no advantage can be derived by exceeding this. As the amount of heat transmitted from the steam to cylinder walls, and *vice versa*, is much lower with superheated steam than with saturated steam, the whole range of temperature from boiler pressure to vacuum can take place in one or two cylinders, so that the use of a triple-expansion engine does not make the slightest improvement in economy. It is not intended to be understood that the author proposes to do away with all triple-expansion engines; for very large plants their use will be necessary for constructive reasons.

With regard to economy obtained from engines working with superheated steam, the gain is derived from the larger volume of the steam and the doing away with initial condensation. Generally the steam consumption of modern engines, working under good conditions, may be taken as follows: Single-cylinder condensing engines, with saturated steam and a pressure of 90 to 100 lbs. per square inch, use 19 to 25 lbs. of steam per indicated horse-power per hour, corresponding to 373 to 490 B. T. U. per minute. The great difference in temperature between admission and exhaust steam causes much waste by initial condensation, and consequently this type of engine especially favors the use of superheated steam. With superheated steam the consumption has been lowered to 13½ to 15 lbs., corresponding to 290 to 335 B. T. U. per minute.

Non-condensing single-cylinder engines gave consumptions of 15 to 18 lbs. of steam per indicated horse-power per hour, which is about the same consumption as an average compound-condensing engine with saturated steam. The non-condensing compound engine decreases the consumption to 14 to 16 lbs. per indicated horse-power per hour. The compound-condensing engine is the most economical, and the economy obtained can hardly be reached by a quadruple-expansion engine working at a pressure of 300 lbs. The steam consumption of such an engine, either compound or tandem, at 140 lbs. pressure only, never exceeds 10 lbs. per indicated horse-power per hour, and usually remains below, many tests having proved 8.5 and 8.8 lbs. consumption per indicated horse-power. To utilize better these temperatures, and to work with various loads with safety and nearly uniform economy, Mr. Schmidt has introduced the receiver heater, with automatic valve. The idea is to keep a steady mean temperature of cylinder walls, not higher than will make the lubrication unreliable for different rates of expansion.

A few words may be said with regard to the cost of a superheated plant. Superheated-steam engines use on an average 30 to 40 per cent less steam than saturated-steam engines of the same type. Consequently boilers can be made 30 per cent smaller, and the difference in price will nearly cover the cost of the superheater. For the same steam consumption the superheated-steam engine is cheaper, as it may be worked with a lower boiler pressure, and it is simpler, i. e., instead of a compound engine with saturated steam, a single-cylinder engine with superheated steam may be used, giving the same, or better, results than the former.

With regard to oil consumption, it was found not to be more than that of an ordinary saturated-steam engine. For example: A 120-i.h.p engine used in 24 hours 4 lbs. of oil, and a 300-i.h.p. Corliss compound engine 2.2 lbs. in 10 hours for both cylinders.

In view of the great advantages of steam superheating and the great number of engines running at present satisfactorily, it is astonishing that a few failures have caused prejudice among some engineers, who make the general introduction of the use of superheated steam very difficult. It will be worth mentioning that the result of a great number of trials has always proved a great saving in steam and coal, and even with small plants and simple piston-valve engines almost the same good economy is obtainable as with large engines with most exact valve-gears. It is therefore recommended that superheated steam should be used in connection with all engines; the only question to be settled is the degree of superheat, which largely depends on local circumstances and the construction of the engine, and this matter should be left to the judgment of an experienced engineer.

[The foregoing is an abstract of a paper read before the Mechanical Section of the International Engineering Congress recently held at Glasgow, Scotland. Mr. Lenke is intimately associated with Mr. Wilhelm Schmidt in his investigation of the problem of the practical utilization of superheat.]

A NEW SYNCHRONIZER.

BY FRED P. WOODBURY.

As the size of alternating-current generators has increased, the necessity of obtaining perfect synchronism before throwing two or more machines into parallel has become more and more imperative, and the synchronizing lamps and voltmeter have become less and less satisfactory. Probably in no power house in the country was the lack of a sensitive synchronizing device more keenly felt than at the big Niagara Falls station, where burned switch contacts due to alternators being thrown in slightly out of step were altogether too frequent. It is largely to this state of affairs that the perfecting of the synchronizer illustrated herewith is due. This instrument was devised by Mr. Paul M. Lincoln, electrician for the Niagara Falls Power Company. While the principle of its operation was described in Mr. Lincoln's paper read before the Buffalo convention of the American Institute of Electrical Engineers, a description of the actual machine and its connections will doubtless be of interest to many readers.

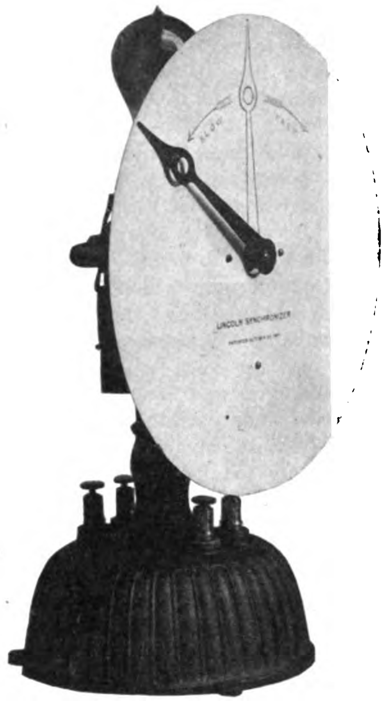


FIG. 1.—SYNCHRONIZER.

The instrument, in size and shape, much resembles an ordinary fan motor, with a dial and pointer replacing the fan and guard. Fig. 1 is a general view of the synchronizer, and Fig. 2 shows the shape of the field and armature punchings. The field magnet or stator is bipolar, and built, of course, of laminated iron, with coils wound to suit the voltage of the circuit on which it is to operate. The rotor is an ordinary armature core, and is provided with two coils wound practically at right angles to each other and connected in series. The shaft of the machine carries three collector rings; the two free ends of the armature winding are connected to two of these rings, and a tap is carried from the other ring to the junction point of the two coils. Suitable brushes are provided, of course, and the shaft is mounted in ball bearings.

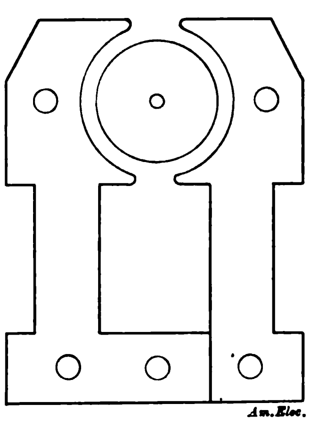


FIG. 2.—FIELD AND ARMATURE PLATES.

Fig. 3 shows diagrammatically the connections. The coils, *F* and *F*, are those on the stator legs, and the two coils, *A B*, are the two armature coils wound at right angles and connected in series. The wire from the common return brush goes directly to the transformer, and the leads from the other two brushes go respectively to an inductance, *X*, and a non-inductive resistance, *R*, the two paths coming together after passing through the inductance and resistance. The resistance, *R*, consists of an incandescent lamp, which is mounted on the instrument and serves to illuminate the dial in one style of instrument. The inductance, *X*, is a reactive coil mounted in the base of the instrument, as indicated in Fig. 4, which shows the instrument turned over on its side so as to expose the interior of the base. The inductance of the coils can be adjusted by changing the air-gaps between the two halves of the core, which are L-shaped. The core is adjusted until the reactance is such as to produce a difference of phase of practically 90° be-

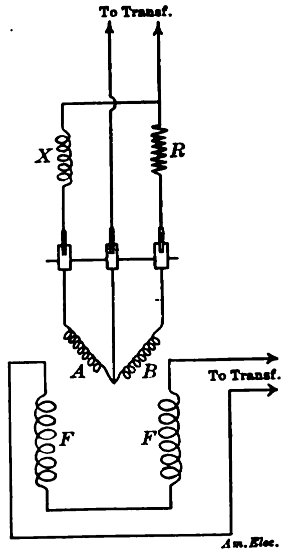


FIG. 3.—DIAGRAM OF CONNECTIONS.

tween the current in the armature coil, *A*, and that in the armature coil, *B*.

For synchronizing, the stator winding of the instrument is connected through a small transformer to the bus-bars, and the leads from the rotor brushes are connected to a pair of bus-wires to which the machine to be synchronized is plugged in through a small transformer. Voltmeter transformers are usually used in connection with the instrument. The self induction in the stator coils *FF* produces a current lag of about 90°. In synchronizing, if the current in the coil *A* is in phase with the current in the stator winding, *F*, the coil *A* will, of course, turn the rotor until its own position is at right angles to the field set up by the stator winding in the air-gap, and as in this case the current in the coil *B* is 90° out of phase with the stator current, there will be no torque between this coil and the stator field. This condition indicates perfect synchronism and carries the pointer to the vertical position over the pointer drawn on the dial. In case the current in the coil *B* should be in phase with the stator current of the instrument, this coil (*B*) will turn at right angles to the field and throw the pointer to a horizontal position, either to the left or to the right, according to whether the machine being synchronized is ahead or behind the bus-bar phase.

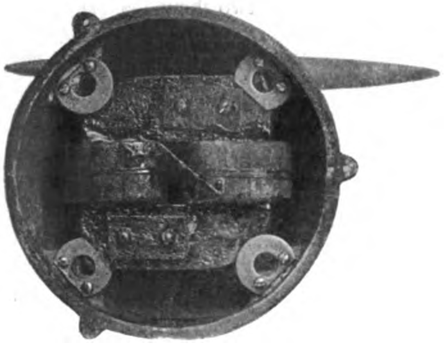


FIG. 4.—BASE OF SYNCHRONIZER.

When the machine is in direct opposition to the machines already running on the bus bars the coil *A* will again set itself at right angles to the field of the stator, *F*, but 180° from its former position and the needle will point downward. Any intermediate phase condition will carry the pointer to an intermediate position on the dial.

The foregoing is what occurs if the machines are running at precisely the same speed, but are simply out of phase or in phase. If there is a difference in speed the pointer will not take up any stationary position, but will rotate at a speed varying with the difference between the speeds of the fresh alternator and those already running. If the alternator being synchronized is running at a slower speed than the machines connected to the bus-bars the pointer will revolve backward; that is to say, counter-clockwise, and *vice versa*. The instrument, therefore, indicates not only difference in phase, but differences in speed.

TRANSVERSE STRESSES IN STEAM PIPES.

BY A. S. MANN.

One important factor to be determined in laying out a system of steam piping is the allowance that must be made for the stresses arising from expansion and contraction due to change of temperature. Whenever a system is being designed which must comprise a main pipe with branches leading out at right angles with the main line to boiler nozzles, some of the branches will be subjected to a transverse stress. This is well understood, and if the main pipe must lie close to the boiler nozzles, from want of room or any other cause, bends and elbows are provided, so that the connections will have spring enough to allow of a change of length in the main. Every steam fitter seems to recognize that a knowledge of these facts is a part of his business, and if he has a line to put up, with long straight runs, he is likely to claim that the provisions for expansion and contraction are quite inadequate; or, as he will usually express it, there is no allowance for expansion at all, if his joints leak or if he meets with any fault in the work when it is put to use. So when he has a line to put up which he must design as he goes along, there is pretty sure to be ample provision for "go and come."

Enough elbows and space nipples with one or two short straight lengths will allow for almost any amount of expansion; just how many elbows and turns must be allowed in a given case is a matter of opinion, and the wisdom in the opinion will depend upon the man's experience. But experience of this kind may not always be reliable, for the rule of proportion does not hold, and different sizes will spring different amounts. Moreover, the kind of joint used will affect the ability of a whole system to spring; a deep thread weakens the pipe, and it will also allow less bending, for though the thinner the pipe the less force it takes to bend it, the less load can it bear without being stressed beyond its elastic limit.

A branch pipe is affected by the expansion of the main line pipe, and also by its own expansion. In the ordinary case the branch must withstand transverse, or bending stresses; or twisting stresses, either singly or in combination, due to the expansion of the main; and it must also withstand compressive stresses due to its own expansion. And to all of these must be added the tensile stresses due to the pressure of the steam within the pipe.

It would seem that a problem of this sort would be altogether too complicated to be solved off-hand by any man, whoever he might be, while he is erecting a system of piping, or even while he is superintending the erection of such a system. There are too many other details to be looked after. If a man has a force of steam fitters and riggers to manage, his fine engineering will have to be done for him at the office, so far as design is concerned at least. His own best engineering is done when he meets and successfully overcomes the ordinary troubles that come up in connection with vibration and freeing the system of water.

It sometimes happens that a large system capable of carrying steam for power in considerable quantity will be laid out without computation of any kind being made in regard to the stresses coming in the various members of the system, or at least, stresses arising from changes due to expansion and contraction. The reasons for this are, first, that the computation is usually a complex one, calling for a good deal of time and care in its performance, and, second, because it is not realized how severe those stresses may become. It is not at all unusual to find a system so laid out that the transverse and torsional stresses are greatly in excess of the tensile stresses due to the steam pressure. An 8-in. standard-weight pipe will be subjected to a stress in tension along its circumferential element of nearly 2000 lbs. per square inch when holding steam at 150 lbs. gauge pressure, and about 1000 lbs. per square inch in a direction parallel with its axis. If two 8-in. pipes, each 5 ft. long, are joined by a right-angle elbow, each of their other ends being rigidly fixed, the transverse stress will have an intensity of nearly 15,000 lbs. when steam of 150 lbs. pressure is turned on, the pipes having been put together without initial stress. In this case the stresses due to expansion are 7½ times as great as those due to the steam pressure itself, and this is not an unusual case. Almost any designer would feel free, if occasion demanded, to join two 5-ft. lengths of 8-in. pipe with an elbow and make the other ends up fast and solid. His greatest stress, that is the stress in his most strained fiber, would be 16,000 lbs. per square inch nevertheless. And this stress will increase as the two pipes are shortened, the two lengths being kept equal. It follows that if one arm were made shorter than the other, the longer one being kept 5 ft. long, a point could be reached when the material of which the pipe is made would be loaded beyond its elastic limit.

There is, for every size of pipe, with given conditions of steam pressure and maximum allowable fiber stress, a minimum allowable length, when joined at right angles to an equal length of pipe of the same or of larger size; and if this minimum point is passed—if two right-angle equal lengths are used, shorter than this minimum—the factor of safety diminishes rapidly, disappearing altogether if the pipes are each made short enough. So far as providing for stresses due to expansion and contraction is concerned, the most desirable material is that which yields (bends) to the greatest extent before fracturing and at the same time has high tensile strength. This explains the desirability of using copper pipe and copper bends when the demands are particularly severe.

There are cases where a very short pipe will seem to take care of an unusual amount of expansion. These conditions will be found to obtain when the support itself is not rigid, and part of the yielding comes from the nozzle or pipe, to which the short pipe is attached. This is equivalent to saying that the short pipe is really longer than it looks to be, and in making plans for a system, whatever spring can be allowed to come in the support should be permitted to go there. Every support, of whatever character, must deflect a certain amount, just as a beam must deflect, however light its load may be.

The first factor affecting this problem is the amount of expansion that a pipe will be compelled to undergo when it is subjected to a given steam pressure and the consequent rise of temperature. It is an easy matter to take from the steam tables the temperature of the steam due to the pressure, and deduct from this temperature the temperature of the pipe when it is erected. Calling this difference the rise of temperature, and multiplying it by the coefficient of expansion for the metal of which the pipe is made, and this product by the length of the pipe, the result is a number which is sometimes taken to represent the "go and come" of the pipe. But the temperature of the steam is not the temperature of the pipe. This is apparent with a bare pipe, for the air must affect the outside in the same manner, if not the same amount, as the steam affects the inside. With a covered pipe, there must be some flow of heat through metal, covering and all, and consequently the average temperature of the metal is less than the temperature of the steam.

From repeated measurements which the writer has made in a number of instances, where lengths have varied, it seems safe to say that 0.00125 may be taken as a factor of expansion with pipe erected under ordinary conditions with the temperature of the metal at 60° F., and then filled with steam of 150 lbs. gauge pressure, the pipe being well covered with magnesia plaster. That is, a pipe thus erected and covered will expand 1½ ins. per 100 ft. of length. This factor is in common use by some steam fitters. It will obviously be affected by the temperature of the surrounding air. It is less when a current of cold air, as from an open door, blows upon the pipe, and is greater in a hot fire-room. But in the hot fire-room the low temperature is greater; that is, the temperature of the metal when steam is shut off, so it would seem fair to take this factor, unless another shall be determined for any particular case.

Further, this factor seems reasonable when compared with the ordinary coefficient of expansion for steel or iron. The coefficient given in Ganot's Physics for wrought iron is 0.0000122 per degree centigrade in units of its length. Taking steam at 150 lbs. as having a temperature of 363° F., and starting with a temperature of erection of 63° F., gives a change of 300° F. or 166.7° C., and $0.0000122 \times 166.7 = 0.00203$; that is, if the iron reaches this temperature of 363° F., it will expand 0.00203 parts of its length, or 2.436 ins. in 100 ft.; 2.44 is sufficiently accurate. If the pipe were to have a temperature halfway between that of the steam inside and that of the air outside, as a bare pipe may be well assumed to have, the coefficient would be one-half the above amount, or 1.22 ins. per 100 ft. This leaves a balance of $1.50 - 1.22 = 0.28$ in. to be accounted for by an increase in temperature of metal, owing to the non-conducting covering. The factor of .00125 proposed above will allow for a change of temperature in the metal of 185° F., and starting with temperature of erection of 63° gives a temperature for the metal of 248° F.

By multiplying the length of a given pipe with this factor, a quantity will be given which represents the deflection necessary in any branch pipe leading out from it. It is evident that the length of the expanding pipe should be reckoned from its anchorage or fixed point, and that the branch pipes must either deflect this amount, or be stiff enough to prevent the main from expanding either wholly or partially. In doing this the main pipe is subjected to compression, and if the stress is simple compression, with no bending stress, it will be unsafe to allow over 45 per cent of the expansion in the main to be restrained, and even this amount will bring a compressive stress of 16,000 lbs. per square inch in its body. This will be apparent from considering the elasticity of the metal. If the allowable stress in compression be 16,000 lbs. per square inch and the modulus of elasticity 28,000,000 inch-pounds, the allowable strain will be $16{,}000 \div 28{,}000{,}000$ or 0.000571, which is 45 per cent of .00125.

In the discussion of this matter, these are the constants which have been used —that is, 28,000,000 as the modulus of elasticity and 16,000 lbs. per square inch as the maximum fiber stress allowable. The former number is usual; the latter is higher than would be allowed in metal subject to steam pressure ordinarily. The reasons for its selection are these. The stress cannot be suddenly applied. The main, or expanding pipe cannot be heated fast enough to make the branch pipe deflect more than this amount; in fact, the load is applied in a regular and gradual manner. There is no way in which this load can be increased; that is, as pressure in a boiler would increase disruptive stresses in its shell if the pressure were allowed to rise accidentally. The stresses are all in the direction of the grain of the pipe, and the load coming from steam pressure is only about one-half its maximum in this direction. Also, systems have been installed, and are now in operation, having branch pipes loaded to give this maximum stress.

REGULATING DEVICES FOR SERIES ALTERNATING-CURRENT CIRCUITS.

BY J. HENRY HALLBERG.

At the recent convention of the Ohio Electric Light Association an interesting résumé paper was read by Mr. Hallberg, in which all of the constant-current regulating apparatus at present in use in connection with series alternating-current arc lamps was reviewed at some length. The following is an abstract of the paper:

There are at the present time in practical use three general methods of control for series alternating-current arc-lamp circuits supplied from constant-potential sources. One method consists of employing arc lamps with differential regulating magnets and an automatic cut-out, which throws into circuit a reactive coil when the lamp ceases to operate. This method is substantially the same as that employed for the operation of lamps in series on a constant-potential direct-current circuit, such as a 500-volt power circuit, the only difference being that the lamp and its substitute impedance coil are designed for alternating current instead of direct. If any of the carbons should slip through their clutches when the lamps are in operation the current in the lamp circuit will increase to an abnormal value, and the fuses may blow or the remaining lamps will draw long arcs of abnormal potential, causing the shunt coils to burn out. This system requires the use of a reactive starting coil in series with the circuit, which is manipulated when the lamp circuit is thrown on. It is evident that such a system does not allow for an increase or decrease in the number of lamps in circuit, and also that in case of a double ground or short-circuit, fuses will blow and all the lamps will be put out. The practical limit of this system is about 12 lamps per circuit for alternating-current work.

A modification of this system consists of a constant-potential transformer with taps led out from the secondary winding to a regulator head similar to the face

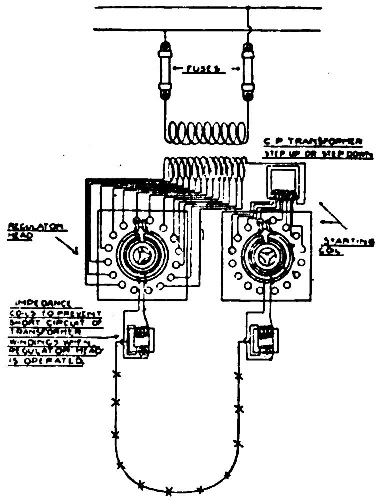

FUSES
C P TRANSFORMER STEP UP OR STEP DOWN
REGULATOR HEAD
STARTING COIL
IMPEDANCE COILS TO PREVENT SHORT CIRCUIT OF TRANSFORMER WINDINGS WHEN REGULATOR HEAD IS OPERATED

FIG. 1.—MANUAL REGULATION.

plate of an ordinary rheostat, the potential of the circuit being adjusted by cutting in or out sections of the secondary winding (see Fig. 1). Relays are provided which cause the regulator head to be operated by means of a spring or a weight in case of short-circuits on the line. A reactive starting coil is also used in connection with this system to prevent the lamps from chattering when they are started up. Neither of the systems mentioned in this and the foregoing paragraphs has any provision for maintaining strictly constant current under variations in line voltage; consequently the current in the lamp circuit will fluctuate if the voltage rises or falls.

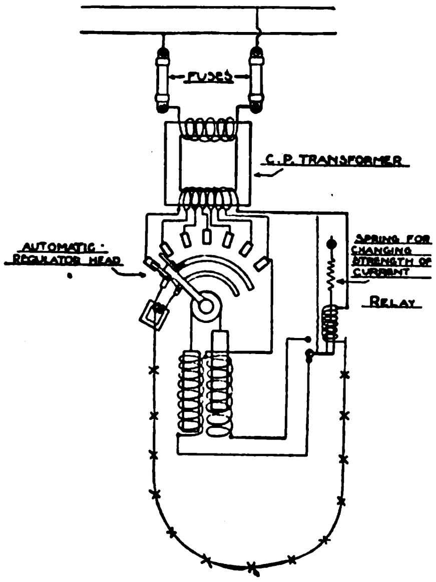


FIG. 2.—AUXILIARY REGULATOR.

The second general method consists of the use of a transformer which converts constant-potential current into constant current. Of these there are two types, one of which is the floating coil or tub transformer. [This has been described so frequently that a detailed description here is unnecessary.] Such a transformer preserves practically constant current in the lamp circuit irrespective of changes in the number of lamps or in the impressed voltage. On account of the inherent current regulation of this type of transformer being limited at full loads, it is necessary to use differentially-wound lamps. In fact, shunt lamps would not operate at all satisfactorily on a fully-loaded constant-current transformer of this type without putting extra resistance or reactance in series with them. The efficiency of a lamp suitable for operation on this transformer would be about 90 per cent when warm, and the efficiency of a 100-light transformer is said to be 96 per cent maximum, so that the maximum efficiency of the system should be about 86 per cent. The power factor of this system will vary within wide range, depending upon the primary voltage, the number of lamps burning, the length of the arcs, style and quality of carbons, and the frequency. The writer has been informed that tests made on this system have shown a power factor of 75 per cent at full load under favorable conditions. The system is not practical when the transformer carries less than three-fourths of its full load, as the power factor falls rapidly below that point.

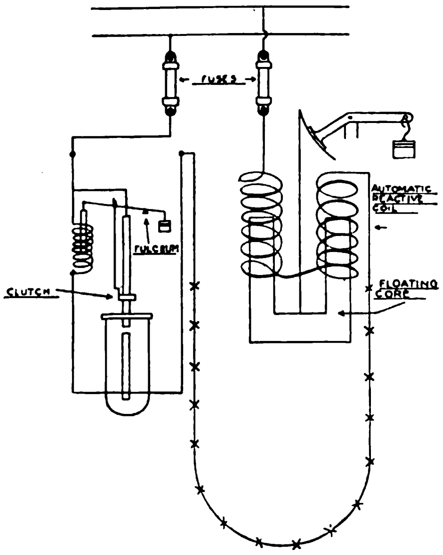


FIG. 3.—REACTIVE COIL REGULATOR.

The other type of automatic transformer comprises a constant-potential transformer with the secondary winding tapped to a regulator head exactly like the second system mentioned above, but in this case the regulator head is operated automatically by solenoids which are controlled by a relay in the lamp circuit, as indicated in Fig. 2. The efficiency of such a transformer, together with its regulator, is about 97½ per cent at full load, and as the differentially-wound arc lamp with about 90 per cent efficiency must be used with this system, the efficiency of the whole system will be about 87½ per cent for circuits of 50 to 100 lights. The power factor is practically constant at all loads.

The third general method of regulation comprises an automatically adjusted reactive coil inserted in series with the lamp circuit, which may be supplied from the secondary of an ordinary constant-potential transformer or direct from a primary alternating-current line. The elements of the system are indicated diagrammatically in Fig. 3; the regulator alone is illustrated by Fig. 4. It consists of two reactance coils or solenoids mounted in a substantial frame and suspended on four spiral springs from a marble slab; a U-shaped iron core suspended below the solenoids from the arc-shaped end of a lever and adapted to move vertically, so that its arms will be inserted into or withdrawn from the solenoid, and a dashpot below the core to steady its movement. A weight is hung from the other end of the lever to counterbalance the core.

Any increase in current above the normal draws the iron cores up into the solenoids until the reactance of the latter is increased to such a point that the current is reduced to its normal value; a weakening of the lamp-circuit current has the opposite effect. When the system is idle the ends of the core are just within the ends of the solenoid, as indicated in the diagram. It is obvious that variations in the number of lamps or in the impressed potential of the circuit will be taken care of by the action of the regulator, which maintains constant current in the line under all conditions within the limits of its range. The efficiency of a 50-light regulator of this type is 98.8 per cent, and the current is maintained constant from no load to full load within 0.2 ampere.

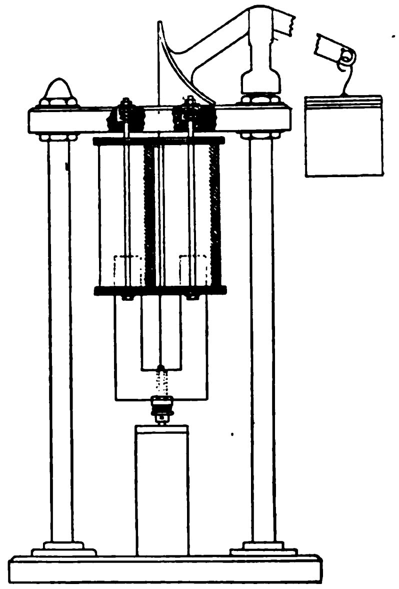


FIG. 4.—REACTIVE REGULATOR.

A strong advantage of this system is that it allows the use of plain shunt-wound lamps instead of the differentially-wound lamps necessitated in other systems. The advantages of shunt-wound lamps for alternating-current work are: high efficiency, maximum possible power factor and simplicity of construction. The elements of the lamp used in connection with this system of regulation are represented diagrammatically by Fig. 5, which is practically self-explanatory. As there are no coils whatever in series with the carbons, the arc voltage is practically the same as that at the hangers. The efficiency of this lamp is 98.6 per cent and its power factor ranges from 88 to 91 per cent, so that the efficiency of the system

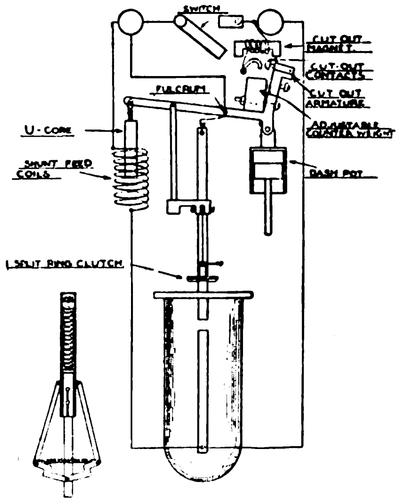


FIG. 5.—SHUNT LAMP.

is 97.4 per cent., and its power factor ranges from 80 to 86 per cent.

The shunt lamp shown in Fig. 5 can also be used as a differential lamp, in which case the counterweight on the rocking lever is omitted and series solenoids substituted for striking the arc. On account of the close regulating qualities of the automatic reactive coil, the series solenoids and their core in the lamp can be made very small; hence, the efficiency of the differential type of lamp used in connection with this regulator is about 94 per cent. The writer believes that the only advantage of a differentially-regulated series lamp over a properly designed and constructed shunt lamp is that there is no flush of current at starting. Therefore, if series incandescent lamps are operated on the arc circuit they will not be subjected to an abnormal rise in current when the arc lamps are started.

American Street Railway Association.

The twentieth annual meeting of the American Street Railway Association was held in Madison Square Garden, New York, October 9, 10 and 11, the proceedings of the convention being held in the large concert hall, while the exhibits occupied to their fullest capacity the amphitheater and a large restaurant room adjoining the entrance hall. The convention was called to order by the president, Mr. Walton H. Holmes, of Kansas City, and welcomed by Mr. Randolph Guggenheimer, president of the Municipal Council of New York City. President Holmes responded to Mr. Guggenheimer's address of welcome in appropriate terms, and then referred at some length to the enormous development of street railway transportation. He pointed out that the manager of a large street railway system was nothing more or less than a merchant selling rides on a large scale, and said that all competent managers now fully realized the necessity for doing a large business in order to make the system profitable, the individual profit on each ride being necessarily very small. The result was that managers are always willing to introduce improvements, even to the extent of discarding substantial and previously valuable equipment when it can be shown that its displacement will bring anything like an adequate return in the way of increased patronage. Mr. Holmes also pointed out the practical value to members of the association of the exhibits of apparatus made in connection with the convention, and strongly urged a careful study of them.

STREET RAILWAYS ; A REVIEW OF THE PAST AND A FORECAST OF THE FUTURE.

The first paper presented to the association was one by Capt. Robert McCulloch, of Chicago, entitled "Street Railways; A Review of the Past and a Forecast of the Future." This paper was read by title, printed copies of the paper having been distributed to the members. The paper was largely reminiscent and extremely entertaining. The author outlined the relatively primitive condition of street railways up to the time when electric traction was introduced, and described the first efforts at electric traction, which consisted of mounting a 7½-h.p. motor on the platform or within the body of the car, and gearing it to the axle by means of chain and sprocket wheels. He pointed out that the street car had ceased to be purely utilitarian, a large portion of street car travel being induced by pleasure alone, and also pointed out the improvement in the condition of life of the working class, who no longer need to live at the threshold of the factory or shop.

Referring to municipal ownership, Mr. McCulloch expressed the opinion with reference to the rapid and expensive changes in the character of equipment during the past few years, that it is questionable if municipalities would have been strong enough and bold enough to have discarded the old and adopted the new. Only the stimulating expectancy of success and reward, he said, could have nerved the individual to the determination and risk that have resulted in the existing conditions. That municipal ownership and control of water-works and electric light plants had been found of advantage, he said, does not warrant the assumption that the same result would follow the municipal operation of street railways. The water and light services may be supplied under the baneful political influences and incumbrances with which they are embarrassed, but it is questionable if the daily transportation of the people of a city would be in safe or capable hands when entrusted to those whose terms of office and position depend on political influences.

H. H. VREELAND.
Newly Elected President of the American Street Railway Association.

RELATION OF INTERURBAN ROADS TO CITY RAILWAYS.

The next paper presented was one by Mr. Ira A. McCormack, of Cleveland, Ohio, entitled "The Relation of Interurban Roads to City Railways." The author expressed the opinion that the relations between these two classes of railway should closely resemble the relations existing between the members of a partnership firm. Both should exert their efforts with the same end in view and miss no opportunity of developing mutual interests, although each may occasionally have individual interests which do not coincide. The question of unusual weights of cars, he said, is the most difficult one to contend with at the present time. The smaller city cars weigh from 16,000 to 20,000 lbs., while the heavier double-truck cars weigh from 24,000 to 30,000 lbs. These are bad enough on tracks which were designed for lighter cars, but the effects of the latest interurban cars, weighing from 35,000 to 60,000 lbs., on the rail joints and special work of city tracks is doubtless becoming fully appreciated by railway men. Another trouble lies in the increase in wheel dimensions. The wheels on city cars have a ⅝-in. flange depth and a wheel face of 2¼ ins., compared with a 1-in. flange depth and a wheel face or tread of 2¾ ins. on interurban car wheels. These differences not only play havoc with special work, but cause a reduction of life of the interurban car wheels, from tearing and chipping the flange. Some standard of measurement should be adopted, but which shall conform to the other and which shall bear the expense are questions which will have to be settled by individual arbitration. In some cities where new construction work is going on, Utica, N. Y., for example, all special work has been ordered with sufficient clearance and groove dimensions to accommodate the interurban standards, but in cities provided with older equipments in good condition such changes are out of the question for some time to come.

Unquestionably, the ideal rail for all-around use is the T-rail, but unfortunately the popular fallacy that this type of rail is wholly unsuited for city use is still deeply instilled in the minds of every layman, owners of vehicles in particular, as well as the majority of city engineers. The author predicted that the day is not far distant when by persistent effort railway managers would be able to convince municipal authorities to the contrary. The only logical argument that can be advanced against the T-rail is that when laid without pavement it is hard on vehicle wheels, but everyone knows that with heavy pavement tracks can be made nearly flush. Of course, such a track can never be as satisfactory to the driver of a tired horse, but it will be a step in the right direction, if for no other reason than that it will do away with lost time, damage suits, and profanity, due to the occupation of street car tracks by horse-drawn vehicles.

The difference in voltage between city and suburban lines is not causing serious trouble. In Cleveland the city lines operate with the ordinary 550-volt potential, while the interurban roads employ 750 volts. Naturally, the cars run at slower speed within the city and do well enough. The only noticeable difference is that the lamps drop considerably when the city current is reached. The city cars have three circuits of five lamps each, while the interurban cars have three circuits with six lamps each. This discrepancy could easily be corrected by cutting out one of the lamps of each circuit at the city limits.

In the discussion following the reading of the paper, Mr. McCormack referred to the difficulty he had found in obtaining information from different companies concerning traffic agreements between suburban and city lines. He said that he was surprised to find that such traffic agreements were made in western cities, but very few existed among street railways in the East. He said that in the West it was the practice when cars of an interurban road enter the tracks of a city line, the city line takes charge of the car as if it were its own, putting on its own crew, collecting all local fares and an extra fare from interurban riders, so that the city line received all the revenue; it pays to the interurban company two cents per car mile.

BEST FORM OF CAR FOR CITY SERVICE.

The discussion of Mr. McCormack's paper extended into the afternoon session; following this discussion, a paper was presented by Mr. Eugene Chamberlin, of Brooklyn, on "The Best Form of Car for City Service." Mr. Chamberlin in his paper advocated a new type of car, which departed from previous practice chiefly in the arrangement of the seats, and incidentally in details of the window sashes. The seats of Mr. Chamberlin's proposed car are of the revolving-chair type, so arranged that they can be thrown into a single line on each side of the car or into pairs, two abreast.

ALTERNATING AND DIRECT CURRENT TRANSMISSION ON CITY LINES.

After a short discussion of Mr. Chamberlin's paper, a paper by Mr. M. S. Hopkins, of Columbus, Ohio, entitled "Alternating and Direct Current Transmission on City Lines," was presented. The author pointed out that the steady growth of outlying districts and the increased suburban traffic incidental thereto, requiring larger and heavier cars and higher speed, have severely taxed simple direct-current distribution methods, among other difficulties being the inadequacy of existing feeder systems to meet the rapidly growing demands made upon them. In attempting to meet these demands one of five courses is usually adopted; first, adding copper to the feeder system; second, raising the voltage on long feeders by means of boosters; third, installing storage batteries at the ends of lines; fourth, in extreme cases building an additional power station located with reference to economy of copper; and fifth, putting in an alternating-current system in the main power station and rotary converter sub-stations at convenient points. The first four of these plans lack flexibility, but it is possible by means of the sub-station plan to have as many feeding points as may be found expedient at a comparatively small outlay and a minimum charge for power house expenses. In many cases the item of station attendance, otherwise the most serious of all, may be eliminated almost entirely by making sub-stations a part of the car house, repair shop, or ticket office, or even the general office.

In installing an alternating-current system in connection with an existing direct-current system, it would seem wise to use a number of small rotary converters located at load centers along the line. The load factor at the station should not materially change from that now existing with direct current, owing to the fact that even if there are violent fluctuations in the amount of power required from any one rotary it is not likely that the maximum demand for power will occur simultaneously at the other rotaries, and if the machine is properly wound and connected in with the existing direct-current system, direct-current feeders should go far toward equalizing the load between rotaries. As a solution of the problem of providing at frequent intervals temporary service much heavier than the usual service, Mr. Hopkins suggested a temporary sub-station mounted on a flat car so that it could be easily moved from point to point, in preference to either the use of a booster or re-inforcing the direct-current feeders. Such a temporary sub-station would divide the current in the track return, reducing the drop to one-fourth of that obtained with a straight feeder. Where the alternating-current transmission voltages does not exceed 6600 volts, he advocated the use of induction motor generator sets, the motor being wound to take the full line potential so as to eliminate step-down transformers.

Mr. Hopkins then described an intended application of the principles mentioned in the first part of his paper to the operation of railway lines in the city of Columbus. The plan outlined by him contemplated an expenditure of $47,000 for rotary converter stations, as an offset to which a saving of approximately $17,500 in cost of feeders would be effected, leaving a net investment of about $29,500 for the sub-stations. On the basis of 0.6 of a cent per kilowatt-hour as the cost of generating current, exclusive of fixed charges, he figured that there would be a net saving in line losses of $3,804 a year, giving a return of over 12 per cent on the investment.

After a short discussion of Mr. Hopkins' paper the president appointed the Committee on Nominations, and the convention adjourned until Friday morning, Thursday being devoted entirely to an inspection of the exhibits in the Garden.

BEST MANNER AND MODE OF CONDUCTING RETURN CIRCUITS TO THE POWER HOUSE.

At the Friday morning session, Mr. E. G. Connette, of Syracuse, N. Y., read a paper on "The Best Manner and Mode of Conducting the Return Circuits to the Power House," in which he indicated the difficulties that had to be met in bonding the rails, and expressed the opinion that the tendency is toward a jointless metallic return by means of electrically-welded or cast-iron joints. Unfortunately, he said, a large number of street railways are not financially able to re-lay their tracks with heavy rails and use the improved method of joint support and connection, and the problem is yet unsolved as to how to bond the rail-joints so as to get perfect connection. The method which he advocated as being preferable for such roads was to use an independent continuous metallic return connected to each rail, the connections being made with ample surface contact and absolutely water-tight. On account of the chemical action which is likely to take place between the copper rivet and the steel rail, the rivet should be coated with a thick layer of solder, lead or tin. In the discussion which followed the reading of the paper, Mr. Roberts said he thought that a good return circuit could be obtained without using a continuous wire. He stated that the matter of cross bonding is an important one. It should be done frequently at the top and bottom of grades, at the end of curves, and at all special work. Mr. W. E. Harrington also thought that an auxiliary copper return was unnecessary, and thought that it was much better to use solid massive rail bonds.

VALUE OF STORAGE BATTERIES AS AUXILIARIES TO POWER STATIONS.

After some further discussion, a paper on "The Value of Storage Batteries as Auxiliaries to Power Stations" was read by Mr. W. E. Harrington, of Camden, N. J. The author stated that the installation of a storage battery in a street railway power station will lead to economical results (1) when the load is of a very fluctuating character; (2) when the peak of the load is of short duration and is either considerably in excess of the average load or in excess of the capacity of the station; (3) when light night loads are to be carried which permit shutting down the steam plant, or (4) when a station is equipped with a diversity of engines and generators having different characteristics. In considering depreciation he stated that a point usually lost sight of is that the depreciation of power-station generating apparatus should be carefully weighed, there being no question that the battery materially decreases the rate of depreciation of the machinery in the station; this reduction in depreciation of the other machinery may more than offset the expense charged as storage battery depreciation. An incidental advantage of a storage battery installation is offered in its lightning arrester capacity. The battery affords, through the electrolyte, an excellent path to ground, as well as acting as a large condenser, and thus serves as the best protection against the serious effects of lightning discharges that can be obtained. The author illustrated the application of the storage battery by reciting the experience which his company (the Camden & Suburban Railway Company) has had with a battery of 300 amperes capacity for a one-hour discharge in conjunction with a station equipment consisting of two 100-kw. Edison generators, one 225-kw. General Electric generator and one 180-kw. and one 250-kw. Westinghouse generators, all belted. A 22-hour test was made with this plant, the result of which showed that with a current fluctuation on the line the extreme range of which was about 500 amperes, the maximum fluctuation on the generators was about 100 amperes. The average charge of the battery was 59 amperes, and the average discharge was 57 amperes, with an average line load of 200 amperes between 1 and 7 p.m., and 350 amperes between 7 and 12 p.m. Referring to battery sub-stations, Mr. Harrington pointed out that the determination of the most economical point at which to locate a battery sub-station requires considerable careful calculation, and gave the formulas which he was in the habit of using for this purpose, these formulas being applicable only to the system of feeding which he had adopted and not generally applicable to any system.

In the discussion of Mr. Harrington's paper, Col. N. H. Heft said that his experience with storage batteries had not been satisfactory from a commercial standpoint, because of excessive depreciation. Mr. F. Uhlenhaut, Jr., of Pittsburg, said that the question of storage battery operation was one of the amount of work required from each battery. In Pittsburg his company had three batteries, all of which were floating on the line and left practically to themselves. Two of these have been in service for about four years, and the other battery for about two years. The first two batteries have given excellent results, with practically no depreciation whatever. The third battery, in service for two years, was found to have been overcharged and had been rather expensive in the maintenance of positive plates. Mr. O. T. Crosby, referring to Col. Heft's experience, said that the different physical conditions surrounding battery installations may explain why in one case excessive repairs are necessary and in other cases the repairs are not so excessive. On a road in which he was interested two batteries had been installed in the same region of the city, both of them having ample capacity for the work to be done. One of the batteries had a disastrous repair account, while the repair account of the other was quite favorable, considering the advantages of the battery. So far as could be ascertained the heavy repair account was due to the fact that the installation was in the basement of an opera house, where the temperature was very high; whereas, in the other battery station, built especially for the purpose, proper provision had been made to maintain normal temperature. Mr. Crosby also suggested that the use of a storage battery on outside lines may be made to extend the area of distribution for direct current and obviate the necessity of installing high-tension rotary-converter sub-stations for such lines. In the neighborhood of Washington recently the operation of a rotary converter sub-station has been discontinued by installing a battery sub-station far out on direct-current lines.

MODERN POWER HOUSE, INCLUDING THE USE OF COOLING TOWERS FOR CONDENSING PURPOSES.

At the Friday afternoon session the first paper considered was one by Mr. J. H. Vail, of Philadelphia, on "The Modern Power House, Including the Use of Cooling Towers for Condensing Purposes." Concerning fuel economy, Mr. Vail stated that the use of pulverized fuel would probably be one of the future methods of securing greater economy in the fire room; first, because more perfect combustion can be obtained, resulting in the possible utilization of a larger proportion of the heat units in the coal; second, because the coal is pulverized by machine and supplied automatically to the furnaces, so that one man can attend the furnaces for at least 1000 horse-power of boilers; third, because of the saving in the handling of ashes, as every available particle of combustible is burned. Mr. Vail stated that most effective and satisfactory results with pulverized fuel were being obtained at many large cement works. The method of burning this fuel with an air blast is the most advantageous. In adopting the use of pulverized fuel, a larger combustion chamber will be required and the boilers should have a larger proportion of heating surface, or else with boilers of a given heating surface and steaming capacity less fuel should be used.

As an illustration of the advantages obtainable from the use of cooling towers in condensing systems he cited the Twenty-Sixth Street station of the New York Edison Company, the maximum capacity of which had been increased by the application of a cooling tower and condensing system from 2600 horse-power to 6000 horse-power. There are now, he said, upward of 500 cooling tower installations in this country, ranging from 250 to 12,000 horse-power capacity. Mr. Vail emphasized the advisability of allowing a liberal margin of capacity over and above the maximum estimated service when installing cooling towers and condensing plants are to be installed, and said that the cooling water should be estimated at not less than 30 times the steam consumption of the engines; the amount of air required should be estimated at 2000 times the quantity of water. As a specimen of the results obtainable with cooling towers, he gave some records from the log book of a power station equipped with the fan type of tower and operated under his own supervision. This log showed that in the month of July, with the atmospheric temperature at 96° and the temperature of the condenser discharge at 130° Fahr., the discharge water was reduced in temperature 37° by passing through the tower, and a vacuum of 24½ ins. obtained at the condenser. Of course, in cooler months the showing was even more favorable, the condenser discharge water being reduced in temperature 45° in January, with the tower fan running at about one-fifth of the speed that it had in July. The cooling tower was located on the roof, and water was elevated 58 ft., using an air pump and jet condenser. With a surface condenser the net results obtained would have been better, as the work on the pump would have been less with a balanced water column. Mr. Vail expressed a preference for the fan type of tower because of its wide range of flexibility, and preferred motor-driven pumps to steam pumps on the score of economy.

ADOPTION OF ELECTRIC SIGNALS ON SUBURBAN AND INTERURBAN RAILROADS.

The final paper was one by Mr. William Pestell, of Worcester, Mass., on "The Adoption of Electric Signals on Suburban and Interurban Railroads of Single or Double Track, and Their Economy of Aperation." Mr. Pestell said that the telephone is rapidly being introduced on electric railway lines for despatching purposes, and while this system has the disadvantage that considerable time is lost by train crews in communicating with the despatcher's office, a telephone system is desirable as an aid in the operation of street railway systems. The object of a signal system for interurban railways should indicate a safe passing point for cars going in opposite directions, so as to give single-track roads with fairly frequent passing points more nearly the same operating conditions as those of double-track roads. All signals, he said, will add a certain element of danger, due to the chances of failure which are inherent in every piece of mechanism. It is important, therefore, to select a signal in which the chances of failure are so slight that only the added safety secured from its use need be considered. In this connection he pointed out that the care bestowed by steam roads on their signal systems was noteworthy. These roads employ trained mechanics, whose duty it is to see that all signals are properly inspected and maintained; whereas an electric road usually puts its signals under the care of linemen or some other men who may know but little of either their principle or mechanical construction. Mr. Pestell went over the list of the various types of signals in use, but thought it would be unwise at this time to make any recommendation covering the type to be used under general conditions. His paper included a copy of the resolutions drawn up by a committee appointed by the Massachusetts Street Railway Association, which resolution recommended the use of a telephone system in conjunction with a proper block system for suburban single-track roads, the telephone system to be owned and operated by the railway company, and the block signal system to be entirely automatic and to contain some other means of visual signal besides incandescent lamps. In the discussion which followed the reading of the paper several members emphasized the fact that a complete signal system was absolutely necessary to the safe operation of electric railway lines, particularly suburban lines.

The discussion was followed by the nominating committee's report, which presented the following names for officers for the current year: For president, H. H. Vreeland, of New York; for first vice-president, C. W. Wason, of Cleveland; for second vice-president, E. C. Foster, of Boston; for third vice-president, H. M. Sloan, of Chicago; secretary and treasurer, T. C. Penington, of Chicago; for members of executive committee, Walton H. Holmes, of Kansas City, Mo.; John A. Rigg, of Reading, Pa.; D. B. Dyer, of Augusta, Ga.; T. J. Nicholl, of Rochester, N. Y., and G. W. Dickinson, of Seattle, Wash. This ticket was unanimously elected, the secretary being empowered to cast a single vote for all the members present.

Abstracts from Foreign Contemporaries

Improved Circulation in Boilers.—Makins' patent cone system for securing improved circulation and consequently increased efficiency, in shell boilers, is described in a recent issue of the London "Engineer." The general features of the arrangement will be readily understood by reference to the accompanying illustrations. Fig. 1 is a separate view of one of the cones which give the system its name, and Fig. 2 shows a longitudinal section of a flue fitted with a series of these cones. From this it will be seen that the system consists essentially of inserting a number of conical shells with hollow walls in the furnace flues—the usual number being five in each flue. These cones communicate with the water above and below the furnace flue by means of pipes. In addition to the five cones of the form shown by Fig. 2 an extra cone (shown to the left of the series in Fig. 2) may be included, the bottom half of which forms a bridge over which the gases pass before reaching the first of the ordinary cones. It is claimed that the whole of the water in the boiler makes a complete cycle of circulation every few minutes, and is consequently at practically the same temperature throughout. Apart from the advantages of increased circulation, the enlarged heating surface materially helps to increase the steaming efficiency of the boiler. Drier steam, it is claimed, is also produced, and priming prevented. The temperature of the gases is said to have been reduced to from 450° to 500° at the end of the boiler flues, thereby approaching very nearly the theoretical flue temperature for the most economical utilization of heat. A test made with a Lancashire boiler showed that the quantity of water evaporated by the boiler was 30 per cent. more during a test with the application of the cone system, than in a test on the same furnace with the ordinary flues.

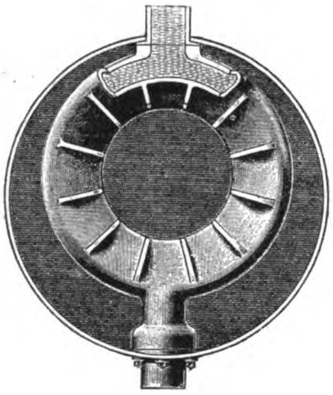


FIG. 1.—MAKINS' CONE.

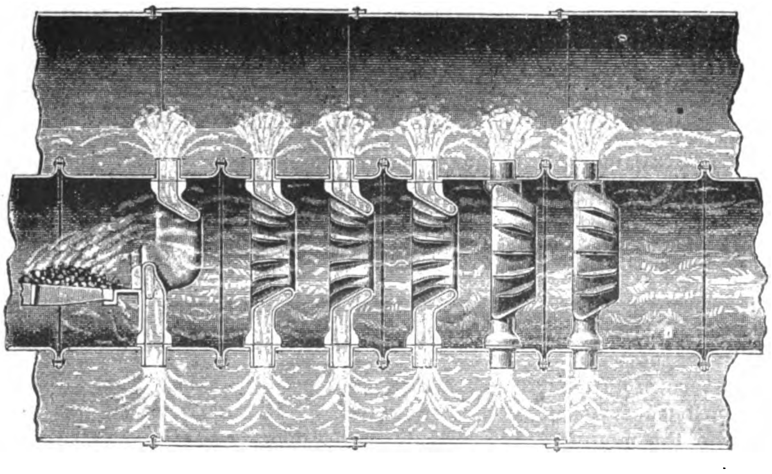


FIG. 2.—FLUE FITTED WITH MAKINS' CONES.

Radical Departure in Boiler Construction.—According to the London "Electrician," there is exhibited in the Queensland Court of the Glasgow exhibition a boiler which should be of interest to engineers, inasmuch as it embodies a radical departure from the usual principles of boiler construction. It is the invention of Mr. Braby, of Queensland. The essential feature of this boiler is the reduction of water space to the lowest possible limit, and the substitution of massive copper slabs as the reservoir of heat in place of water. The chief source of danger in a boiler is the hot water it contains under pressure, and the larger the water space the more damage will a boiler do when it explodes. On the other hand, the hot water, serving as a reserve of steam power, enables the boiler to promptly meet any sudden increase in the demand for steam. Several inventors have devised inexplosive boilers on the "flash" principle, which consists of abolishing practically all the water space and causing the boiler to evaporate a thin stream of water as quickly as this is injected onto the heating surface; but it has been reserved for Mr. Braby to modify this type of boiler by providing it with a much greater heat capacity than the ordinary design, at the same time retaining its inexplosive character. The heating surface in the Braby boiler consists of large slabs of copper, through which the steam passages are drilled out. These slabs are placed in the furnace and are exposed to the hot gases on their outer surfaces. The feed water, having been previously heated in a cooler part of the furnace, is forced by a pump into the passages through these copper slabs, and is instantly raised to steam. Should any sudden demand for more steam arise, Mr. Braby claims that all that it is necessary to do is to turn on more water, the reserve of heat stored in the mass of the copper slabs promptly evaporating the required larger amount.

Induction Meter.—In a recent issue of the "Elektrotechnische Zeitschrift," F. Schrottke describes an interesting induction meter built by Siemens & Halske. Its general arrangement is shown by Fig. 3, in which *A* is a ring formed of thin sheets of iron, with four pole pieces, *E E* and *F F*. Inside them is a laminated iron

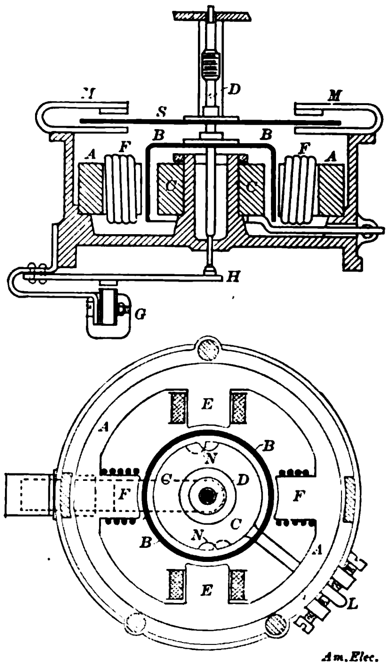


FIG. 3.—INDUCTION METER.

core *C*, around which there is placed a very light drum, *B*, of aluminum, movable around the axle *D*. The poles *F F* are wound with a few turns of heavy wire, while *E E* are wound with many turns of fine wire; the former being the current coils and the latter the potential coils. The torque produced upon the aluminum drum is proportional to the product of the currents in the two coils and the sine of the phase difference between them. Herein lies the difference between the induction meter and the dynamometric meters; the torque in the latter being proportional to the cosine instead of the sine. When an induction meter is used, it is necessary to use a device whereby the current in the potential coil of the meter is out of phase by 90° with the e.m.f. producing it. The phase splitting device is shown in Fig. 4, where *R R R* are non-inductive resistances and *S S* the potential coils of the meter. An inductance coil *D* is in series with this arrangement, as shown. The current in the potential coils *S S* is in quadrature with the e.m.f. between the terminals P_1 and P_2. The device is adjusted by varying the central resistance, and its sensitiveness varied by varying the resistances between *A* and *E*, and *B* and *C*. The magnetic damping disk is indicated by *S* in Fig. 3; it is of aluminum and runs between the poles of strong permanent steel magnets, *M M*. Two small slots, *N N*, are provided in the iron core *C*, the latter being adjusted angularly by means of the screw device *L*. When the two slots are in the position indicated by dotted lines, there is a slight dissymmetry of the field of the potential coils, which produces the desired compensation. To prevent the meter running on no load, four notches are cut in the lower rim of the revolving drum *B*. The resistance of the drum is therefore slightly different in one direction from that in the direction perpendicular to it. The drum takes a position before the poles carrying the potential coils, so that the current produced in it is a minimum. To render the meter free from error owing to external vibrations, the movable system is kept continually in very quick vibration by means of a small electromagnet *G*, the armature of which causes the spring *H*, which holds the agate bearing, to vibrate. The meter is said to stand long overloads up to 30 per cent, and short overloads as high as 100 per cent.

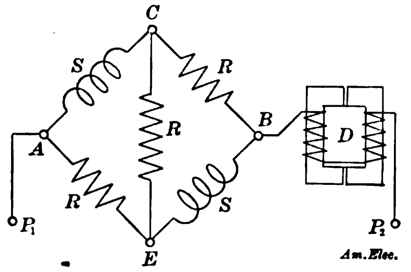


FIG. 4.—PHASE SPLITTING DEVICE.

Lahmeyer Motor Generator.—London "Engineering" describes, in a recent issue, the Lahmeyer motor generator for converting three-phase alternating currents into direct current. This machine is shown in section, and side and end elevations by Figs. 5 and 6. It is of 65 kilowatts capacity and consists of a synchronous three-phase motor and an ordinary direct-current dynamo set upon the same shaft. The left-hand part of Fig. 5 shows the generator, and the right-hand part of the motor. In Fig. 6 the motor is shown to the left of the vertical center line, while to the right of the same line is represented the direct-current generator. The motor is designed to receive three-phase alternating currents of a frequency of 50 cycles and 120 volts. It has a fixed external armature and an internal 10-pole rotating field magnet; the speed required to run in synchronism with the above supply current is obviously 600 r.p.m. The motor field magnet is excited by 620-volt current taken from the generator through two slip rings shown to the right in Fig. 5. The diameter over the pole faces is 31 inches. The generator is of the ordinary multipolar type, with 6 poles; the armature is slotted and drum wound, the winding being of flat bar copper. The diameter at the pole-faces is 24 ins.

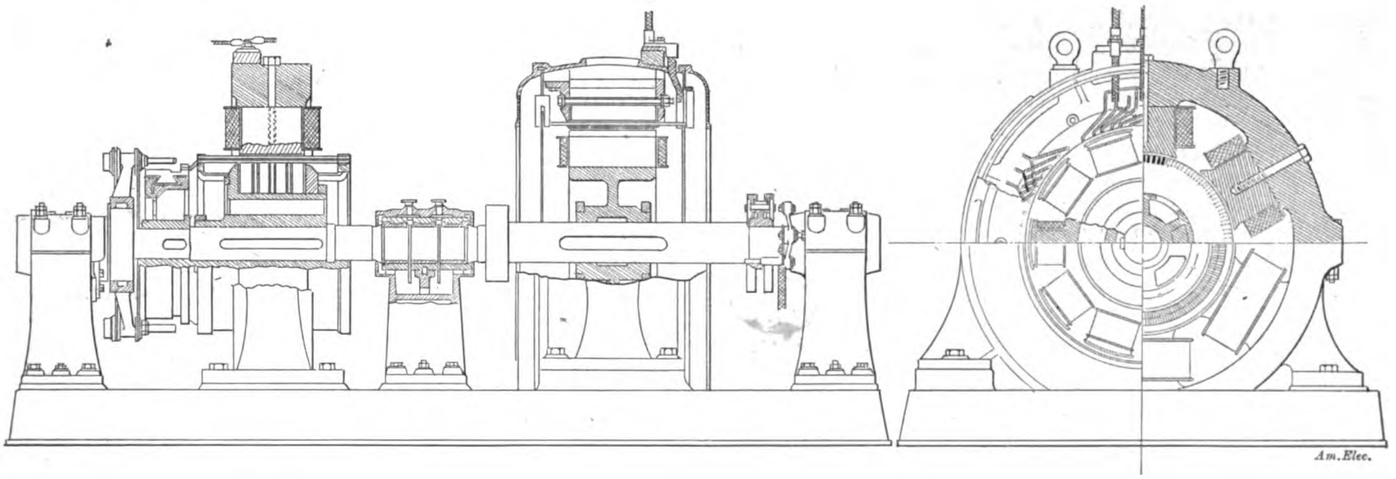


FIG. 5.—LAHMEYER MOTOR GENERATOR.—FIG. 6.

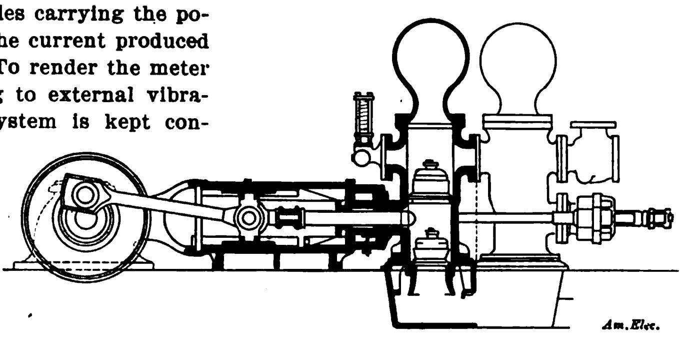


FIG. 7.—SCHLIEFMUEHLE ELECTRIC EXPRESS PUMP.

Electric Express Pump.—The "Practical Engineer" of London contains a description of the Schliefmühle electric express pump, a longitudinal section of which is shown by Fig. 7. The arrangement of the working parts is shown in the engraving, and little further explanation is needed beyond mentioning that the plungers measure 4 ins. in diameter and have an 8-in. stroke. Special care has been bestowed on the stuffing box, which has been made rather long in order to more thoroughly guide the plunger. The latter is a simple hollow casting. Only two valves are used, and these are automatic in action, of the multiple-ring type, with bronze seats and hard rubber washers. They are mounted vertically one above the other in a common valve chest, the plunger working between them. The water consequently has only to travel a short path. Under the three valve chests of the triple pump is placed a common air chamber, which also forms part of the solid frame, while each of the valve chests is provided above with a separate air chamber containing air under pressure, introduced by a small air compressor. A water gauge indicates the volume of air in each chamber, and a pressure gauge is provided for recording the pressure; a safety valve being attached to guard against sudden and abnormal pressure. The circulation and distribution of the lubricating oil is ensured by a small oil pump on the frame. The stuffing boxes are oiled separately by means of annular grooves. The working speed is 250 r.p.m.

The Efflux of Steam.—The calculation of steam turbines depends upon a knowledge of the laws which determine the escape of steam through converging or diverging orifices. In order to verify exactly the formulæ for the escape of steam, M. A. Rateau, of Paris, undertook a series of experiments, the results of which are embodied in a paper read before the International Engineering Congress at Glasgow and published in the London "Engineering." The author, unlike his predecessors, carried on his investigations by condensing the steam in a stream of water, with the use of an ejector-condenser; and by measuring the total yield of water and the initial and final temperature of the stream. Fig. 8 represents diagrammatically the apparatus employed. *A* is the ejector-condenser which receives steam through the pipe *B*, and cold water by the pipe *C*. The hot water containing condensed steam escapes by the pipe *D* into the sheet-iron chamber *E*, where the air separates out; then it goes out through the converging orifice *F* at a pressure measured by the water gauge *h h*. The rise in temperature of the water is measured by the thermometers *e* and *f*, graduated to twentieths of a degree, and previously calibrated by comparison with a Baudin thermometer. The nozzle to be tested is placed within the pipe at *I*. It receives the vapor through the pipe *H*, and throws it into the large pipe *B*. The initial pressure was measured by one or other of the gauges *a* or *b*. The resultant pressure was measured by either the metallic pressure gauge *m*, or the mercury gauge *c d*. The steam arriving from the boiler by the pipe *N*, rushes with centrifugal force into the separator *J*, on account of the partial vacuum therein, and the small quantity remaining can be measured by the specially arranged apparatus *L*. The pressure before passing the nozzle can be regulated at will by means of the cock *K*; a special valve actuated by the crank *g* enabling the pressure to be fixed at any desired amount above the lowest pressure caused by the ejector-condenser. The rate of flow through the water orifice *F* had been previously measured by means of the barrel *G*, graduated along the tube *k, k*. The values obtained corresponded approximately to the theoretical values calculated from Regnault's tables by the thermodynamical formula; the mean of the results giving a figure seven-thousandths in excess of the results obtained by the theoretical calculation.

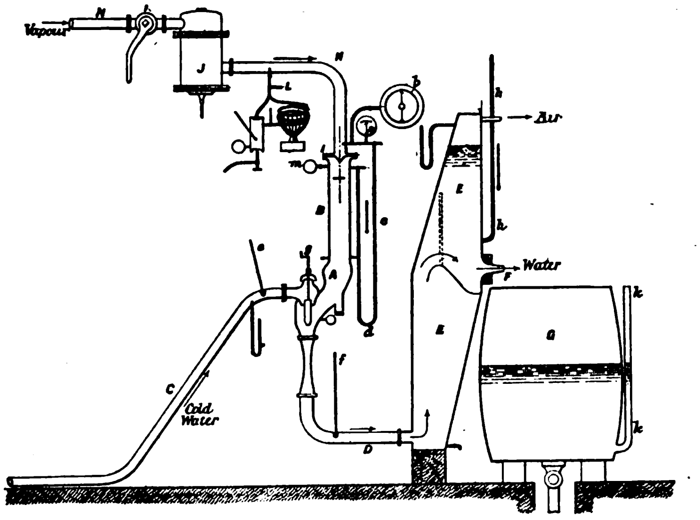
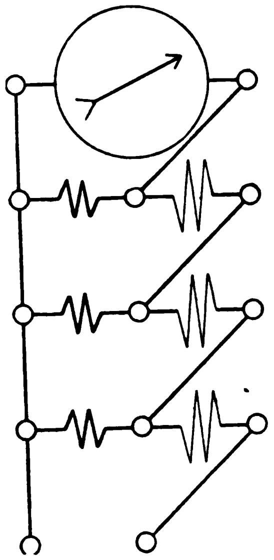


FIG. 8.—APPARATUS FOR MEASURING THE EFFLUX OF STEAM.

Galvanometer Shunts.—In altering the sensitiveness of a galvanometer, shunts are used which have a resistance equal to a certain fraction of the resistance of the galvanometer. But when such a resistance is connected in parallel with the galvanometer the joint resistance of shunt and galvanometer is less than the resistance of the galvanometer alone. By adding a proper series resistance it is possible to have such an arrangement whereby the entire resistance is equal to the galvanometer resistance alone. Wilhelm Volkmann describes such an arrangement in a recent issue of the "Elektrotechnische Zeitschrift," from which Fig. 9 is taken. The heavy zig-zag lines represent the shunts, and the light zig-zag lines the series resistances. The resistances of the shunts are $^1/_9$, $^1/_{99}$ and $^1/_{9999}$ respectively, and the three series resistances are $^9/_{10}$, $^{99}/_{100}$ and $^{9999}/_{10000}$. The following seven combinations are then possible. Each shunt and series resistance alone, the first and second together, the first and third together, the second and third together, and all three together. A practical arrangement is shown in Fig. 10. The points *I I* are connected to the galvanometer. Plugging 2, 4 and 6, short-circuits the series resistances. Below the numbers 10^{-1}, 10^{-2}, 10^{-4} in the diagram are the shunt resistances, which are traversed by current when the holes 1, 3 and 5 are plugged. It will now be seen that by plugging holes 2, 4, 6 the sensitiveness is 1; by plugging holes 1, 4, 6 the sensitiveness is 0.1; by plugging holes 2, 3, 6 the sensitiveness is 0.01; by plugging holes 1, 3, 6 the sensitiveness is 0.001; by plugging holes 2, 4, 5 the sensitiveness is 0.0001; by plugging holes 1, 4, 5 the sensitiveness is 0.00001; by plugging holes 2, 3, 5 the sensitiveness is 0.000001; and by plugging holes 1, 3, 5 the sensitiveness is 0.0000001. By this means it is possible to convert a milliammeter into an extremely sensitive galvanometer.



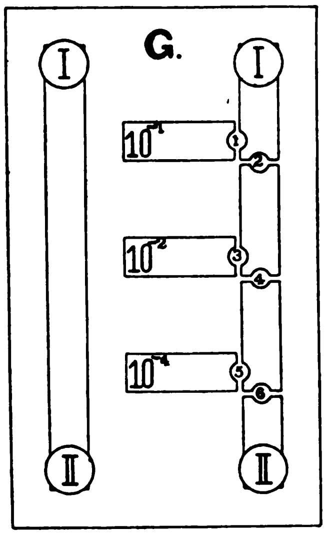


FIG. 9.—GALVANOMETER SHUNTS —FIG. 10.

Electrolysis of Fused Alkali Chlorides.—It has long been known that the yield of sodium in the electrolysis of fused sodium chloride decreases with a rise in temperature, and since a mixture of the chlorides of sodium and potassium melts at a considerably less temperature than either of the salts separately, such mixtures have been used. If equivalent proportions of both salts be used and the sodium chloride afterward constantly replenished, the electrolysis gives a sodium containing less than 1 per cent of potassium, and this is sufficiently pure for many technical purposes. In investigating the causes of sodium losses, Arthur Fischer, of the Aachen Technical High School, according to London "Engineering," dispensed with a special crucible, and dipped the two electrodes directly into the salt mixture, employing the current heat to keep the salts in fusion. It was observed that the sodium did not appear to rise from the cathode, but from a point between the two electrodes. It is explained that the free liberation of chlorine at the anode causes a brisk convection current toward the anode in the lower portion of the fused mass. This current partly carries the sodium particles with it, so that in rising from the lower extremity of the cathode they are deflected in a curve and appear in the surface layers to return to the cathode as though coming from the anode. In order to keep the sodium from going astray, Fischer surrounded the cathode with a hood, resembling somewhat a hat, the brim of which forms a cooling pipe. The fused salt solidifies on this ring and the liberation of sodium remains confined to the inner space of the hood. The whole mass, however, was apt to solidify, and when the crust of resolidified salt had commenced to crack and peel off, the copper pipe was quickly eaten through at spots opposite the anode; the copper evidently playing the part of an intermediate electrode on which sodium appeared. A proper insulation of the cathode was advisable; but few insulators will act in fused salts. One of these is marble, and marble slabs were tried in various ways. The two electrodes were finally arranged horizontally in alignment in an iron box, across which a cooling trough of marble was placed, dipping a little into the mass. The anode was a carbon rod; and the cathode a hollow iron pipe, through which the sodium, which floated on the salt, flowed off. With this arrangement the convection currents were obviated; but the fused salt became sluggish, and the electrolysis more and more limited to the neighborhood of the anode. Provision must therefore be made for the quick removal of the sodium.

Revolving Light Synchronizer.—The London "Electrician," through its special correspondent, described recently the new revolving light synchronizer of Schuckert & Company, Germany, which consists of a number of incandescent lamps connected to the secondary of a three-phase transformer. Each of the primary coils of this transformer is connected to a bus-bar and to one of the terminals of the machine, to be switched in parallel with the others. The secondary coils of the transformer are connected star fashion, as shown by Fig. 11, which also shows the manner in which the lamps are connected. For the sake of simplicity only one-half of the lamps are shown, each of the remaining lamps being connected in parallel with one of the others. Each of the secondary coils is divided into two parts by the lamp connections, and the point of connection is so chosen that the number of turns between this point and the common terminal of the star bears the ratio of 1:$\sqrt{3}$ to the total number of turns on the winding. The voltage in the primary coils is at any moment the geometrical difference between the voltage delivered at the bus-bars and the machine terminals, and the voltage in the secondary coils is proportional, of course, to the primary pressure. If the machines running and the one to be switched in are in synchronism, the distribution of the voltage in all three coils is the same, and consequently the lamps connected to the coils burn at the same voltage. The distribution of voltage among the individual lamps, however, varies. Certain lamps receive maximum voltage and burn brightly; others of them receive less and are dim; while there are still others which receive no voltage at all and emit no light. The distribution of the voltage to the lamps depends on the difference in phase between the primary e.m.f.'s. In using the apparatus, the switchboard attendant watches the dial until the light stands still and does not appear to rotate in either direction, and then throws the switch. The lamps forming the diameter of the circle are connected as the lamps of an ordinary synchronizer and burn at maximum brilliancy when the machines are in phase. If the apparatus is to be used for connecting single-phase machines in parallel, a self-induction or capacity must be used as a phase-splitting device to provide an auxiliary phase.

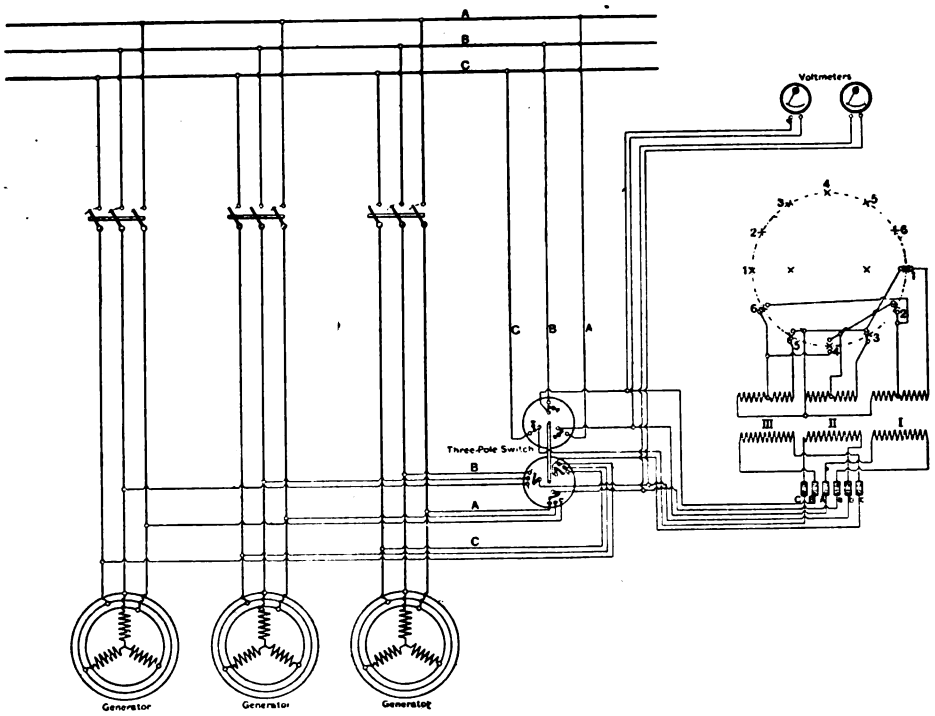


FIG. 11.—DIAGRAM OF CONNECTIONS, REVOLVING LIGHT SYNCHRONIZER.

New Form of Platinum Electrode.—The electrolysis of chloride solutions on a commercial scale has been handicapped more or less by the difficulty in finding a durable and cheap form of anode. Gas carbon anodes, while cheap, are not durable, while platinum, on the other hand, is durable, but so expensive that its use has been restricted to factories where hypochlorites or chlorates are the final product of the electrolytic cell. Many attempts have been made to devise forms of platinum anode which shall give a large superficial area of surface per unit weight of metal employed. Fig. 12, taken from the London "Electrician," shows a vertical section of a new electrode made by the German firm, Heraeus, of Hanau-on-the-Main, which is said to meet this requirement. Into a glass tube, *A*, the lower end of which is closed by fusion, are fused a number of platinum wires, *B B B*, and to the projecting ends of these wires, strips of platinum foil, *C C*, 0.8 in. wide and only 0.0003 in. in thickness, are attached by autogenous soldering. The connection with the current supply is provided by an equal number of copper strips, *D D D*, which pass down the interior of the tube and are soldered to the portions of the platinum wires which pass through it. The upper ends of these strips are soldered to a copper block, *E*, by which electrical connection with the main conductor is rendered simple. If this block *E* be made of suitable form, any number of these glass tube electrodes can be hung upon an insulated cross-bar carrying the current. An electrode constructed in this way, with an active surface area of 10.75 sq. ft. will only require 100 grm. of platinum, and, although the foil used is extremely thin, yet the cross pieces of platinum wire to which it is attached give to it considerable mechanical strength. A further advantage offered by this form of electrode is that the loss of e.m.f. by internal resistance can be reduced to a minimum by using sufficiently thick copper wires to make the connections in the interior of the tube *A*, and that by increasing the thickness of these wires and of the cross wires, the electrode can be adapted to currents of very high intensity. The current density is also rendered fairly regular at all points upon the surface of the electrode, owing to the nu-

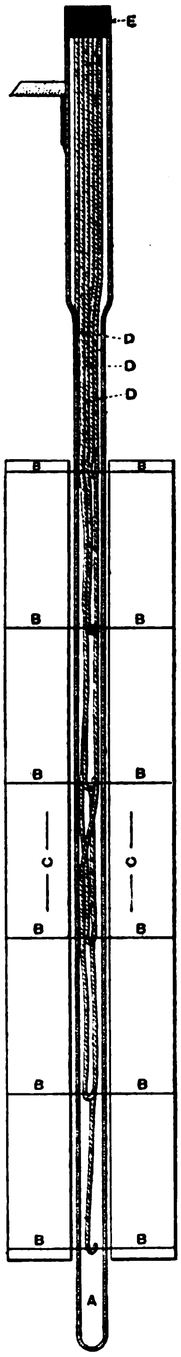


FIG. 12.—PLATINUM ELECTRODE.

merous connections made between it and the main conductor by the cross wires upon which the platinum foil is fixed. If care be used in the construction of these electrodes, they stand well both in hot and cold electrolytes, and the glass tubes do not crack or break at the points where the platinum wires pass through them.

Some Recent Electrical Patents

Wall Receptacle and Fuse Plug.—Fig. 1, herewith, illustrates one of the latest additions to the list of wall receptacles and attachment plugs. The form here shown was devised by Hans O. Swoboda, and its principal feature consists of the use of a ring-shaped handle pivoted to the face of the plug and adapted to be folded up flat against it, so that the lid of the receptacle may be closed while the plug is within it. In order to facilitate the use of this arrangement the flexible cord is carried through a hole in the bottom of the face of the plug instead of through its center, as is commonly done. Fig. 1 shows the plug within the receptacle with the ring handle opened outward for the withdrawal of the plug, and Fig. 2 is a cross-section of the plug and receptacle, with the handle folded in and the receptacle cover closed. Patent No. 683,579.

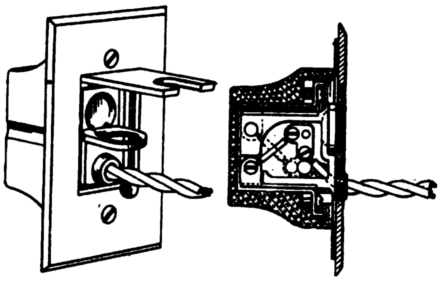


FIG. 1.—WALL RECEPTACLE.—FIG. 2.

Magnetic Speed Indicator.—Several forms of speed indicator have been devised in which the speed measurement is accomplished electromagnetically, a familiar arrangement being one in which one or more revolving permanent magnets induce foucault currents in a copper disc normally held at zero position by restraining springs. A patent recently issued to Simon B. Storer describes a speed indicator in which the action of foucault currents is utilized, but in a manner differing considerably from the common method. Fig. 3, herewith, is a cross-sectional view of the instrument; a cylindrical permanent magnet, *A*, is employed; this is held stationary, and the revolving member, driven by the spindle, *T*, through a multiplying gear, consists of a copper cylinder, *d*, revolving between the poles of the cylindrical magnet. In addition to these elements there is provided a soft-iron armature, *c*, which is delicately pivoted on a spindle, *E*, which also carries the pointer of the instrument. The armature is normally held at the zero position by two restraining spiral springs, *F'* and *F*, which are more clearly shown in Fig. 4. The wall of the armature, *c*, is not a continuous cylinder, but is divided up, preferably, into projections or fingers, so that as the copper cylinder, *d*, is rotated and the foucalt currents generated therein drag the magnetic field around, this field tends to carry the armature, *c*, with it. The force of the pull on the armature is, of course, indicated by the pointer of the instrument. The instrument is rendered dead-beat by means of a copper facing, *n*, on the inner pole of the permanent magnet, which tends to check any oscillation on the part of the soft-iron armature, *c*. Patent No. 680,988.

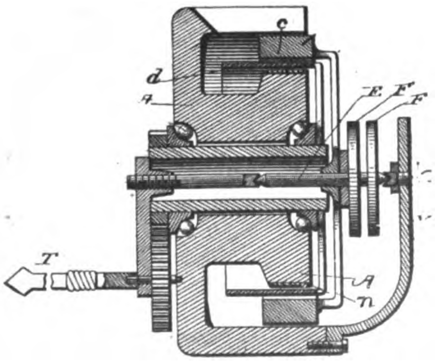


FIG. 3.—MAGNETIC SPEED INDICATOR.

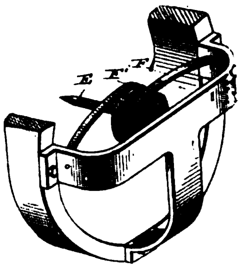


FIG. 4.

Insulation Testing Device.—In order to provide a means of indicating defective insulation in cables or other insulated conductors, Isidor Kitsee has devised a plan of connecting a high-resistance sensitive electric bell or other indicating device between the electric light or power conductor and the sheathing of the cable. In the case of conduit wiring, the bell or indicating device would be connected between the electric conductor and the metallic conduit pipe. The patent also covers the use of an insulated conductor for heavy service currents, surrounded by a spiral wrapping of conducting material, the alarm device being connected between the conductor and the outer metallic wrapping, which is preferably of tinfoil. Fig. 5, herewith, illustrates the application of the system to two conductors within a single conduit tube. Patent No. 682,204.

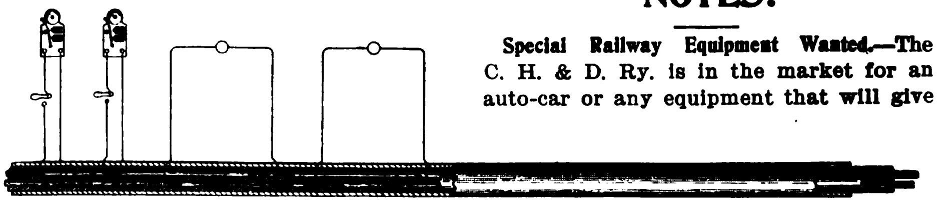


FIG. 5.—INSULATION TESTING DEVICE.

Cable for Three-Phrase Currents.—It is, of course, well known that three-phase distribution is more economically effected by adding a fourth conductor to the three principal conductors, the fourth wire being connected to the neutral point of the system. The distributing potential with such a system being that measured from each of the principal wires to the neutral wire, instead of the e.m.f. between two of the main wires, this latter pressure may be made 1.73 times the distributing pressure, and a corresponding saving may be effected in copper. With a view to providing a fourth conductor without increasing the size of a cable beyond the size that it would naturally have when containing only three main conductors, Wm. B. Esson, of London, has devised the arrangement illustrated by the accompanying engravings, Figs. 6 to 9, inclusive. In all of the engravings the three main wires are indicated by the figure 1, the remaining smaller wires being grouped together to form a neutral. In Fig. 6 the neutral consists of three wires in parallel, these three being disposed in the spaces between the three main wires. In Fig. 7 the neutral conductor is divided into four strands, symmetrically disposed. In Fig. 8 it is divided into seven strands, and in Fig. 9 it is divided into two strands unsymmetrically disposed with relation to the entire system. These two strands are indicated by the figure 2. The third small circle, indicated by the figure 6, is a cord or other dummy strand put in to give mechanical symmetry in manufacture. This method is illustrated merely to indicate that the strands forming the neutral need not necessarily be laid with perfect symmetry with regard to the geometry of the complete cross-section. Patent No. 682,845.

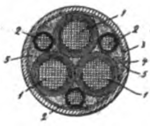


FIG. 6.

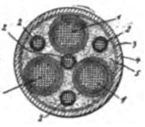


FIG. 7.

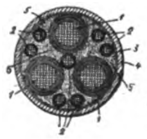


FIG. 8.

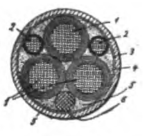


FIG. 9.

◆

NOTES.

Special Railway Equipment Wanted.—The C. H. & D. Ry. is in the market for an auto-car or any equipment that will give an independent movement of a railroad passenger coach for suburban travel. Mr. D. G. Edwards, C. H. & D. Traction Company, Cincinnati, Ohio, can give full particulars.

Municipal Lighting Plant to Be Installed.—The authorities of the city of Bradner, Ohio, have decided to install an electric-light plant to cost $13,500. Edward Y. Dow, Toledo, Ohio, has been appointed engineer for the installation of the plant.

Ten Lectures for Electrical Workers.—It is announced that a series of ten lectures of an elementary character on electricity and electrical apparatus will be delivered at the New York Trade School, First Avenue and Sixty-seventh Street, New York, beginning November 1. The lectures will take place two weeks apart and will be illustrated by experiments and demonstrations. Further information may be obtained from the school.

Railways in Italy.—From railway statistics recently issued it would appear that there is still room for considerable development in electric traction in Italy. Of 3179 kilometers (1975 miles) of railway operated by mechanical traction there are but 263 kilometers (163½ miles) worked electrically. These lines are divided into small sections and are owned by sixty-four companies. At Milan—a city of considerable importance—there are but 5½ kilometers (3½ miles, scant) worked by electric traction.

First New Unit of the New York Edison Company Started.—On Thursday night, October 24, the first of the 8000-h.p. generating units in the new station of the New York Edison Company was started up. This unit, consisting of a Westinghouse-Corliss vertical engine and a General Electric three-phase alternator, was loaded to the extent of 5500 horse-power and has been carrying that load smoothly ever since starting. The engine is running non-condensing temporarily, the work of connecting up the condenser not being quite completed; as soon as the condensing plant can be started the full load will be put on the generator. It is expected that the second unit will be started in four or five weeks.

Telephone Extensions in Washington.—It is stated, on the authority of Col. T. W. Tyrer, secretary of the Telephone Company of America, that his company will endeavor to obtain a franchise for a telephone exchange system in Washington, D. C., which, if constructed, will cost $3,500,000. If the franchise is obtained the company proposes to establish 100,000 telephones in the city to be used on a rather unusual basis. No charge will be made for the installation and no contracts for specific periods will be made; each use of a telephone, however, will cost two cents. Telephones will be put in hotel rooms, and the residences of persons in moderate circumstances will be equipped, as well as those of the wealthier citizens.

Electrician Wanted.—We are advised by Messrs. F. E. Bailey & Co., contracting engineers, of Manheim, Pa., that a man hailing from New York, and claiming to have been superintendent of two electric-light plants in the West, and to have been employed by several representative contracting firms and central stations, is making it a business to secure employment with electric-light companies, and after working a few weeks, to ask for an advance of money, and then disappear, carrying with him a lot of tools belonging to the company. We understand that he has played this game on the Manheim Electric Light, Heat & Power Company, Manheim, Pa., who are desirous of obtaining any information as to his whereabouts.

Contracts for Station Apparatus for the New York Rapid Transit Subway.—The Rapid Transit Subway Construction Company, of New York, which is to operate the rapid transit tunnel when completed, has contracted with the Westinghouse Electric & Manufacturing Company for the electric generating apparatus, which is to include six 5000-kw. three-phase generators of the revolving-field fly-wheel type, to run at 75 r.p.m. and deliver current at 11,000 volts and a frequency of 25 cycles. They are rated at 263 amperes per phase, non-inductive load. Three exciters will be used, each of 250 kilowatts capacity at 240 r.p.m. and 250 volts. For the sub-stations 26 rotary converters, each of 1500 kilowatts capacity, are to be furnished. These are to give 625 volts on the direct-current side and will run at 250 r.p.m. For starting these rotary converters there are to be eight motor-generator sets in the various sub-stations, consisting of induction motors coupled to direct-current generators. There will be 78 step-down transformers, each of 550 kilowatts capacity, giving 390 volts at the secondary terminals, with primary voltages of 9500, 9750, 10,000, 10,250 and 10,500.

Trials of Steam Turbines.—In a paper read by Mr. Chas. A. Parsons before the Mechanical Section of the International Engineering Congress, recently held at Glasgow, some interesting results of steam turbine tests were presented, among which were the following:

Tests of Various 500-kw. Generating Units, Turbine and Alternator.

Pressure of steam above atmosphere at stop valve	Superheat at stop valve.	Vacuum in the turbine cyl. Bar. = 30 ins.	Revs. per minute.	Load.	Steam used.	
		Scarborough Electrical Supply Company.				
Lbs. per sq. in.	F°	Ins. of mer.		Kw.	Lbs. per hr.	Lbs. per kw.-hr.
126	0	26.75	2400	529	12,023	22.7
128	0	27.7	2400	258	6812	26.4
164	0	28.1	2600	0	1477	....
		Cheltenham Corporation.				
130	0	26.7	3000	553	12,000	21.7
130	0	26.6	3000	278	7280	26.2
133	0	24.0	3000	553	13,060	23.6
130	0	24.0	3000	453	11,250	24.8
135	0	24.0	3000	276	8175	29.65
		Blackpool Corporation.				
146	70	27.1	2500	515	11,000	21.35
150	0	27.0	2500	502	11,600	23.1
135	0	27.3	2500	497	11,953	24.0
133	66	27.3	2500	507	10,693	21.1
152	0	29.0	2500	0	1500	....
160	0	23.6	2500	0	2530	....
156	5	28.9	2500	0	1465	....

It will be noted from the above results that the improvement in steam consumption resulting from a superheat of 50° F. is about 8 per cent, and from 100° F. it averages about 12 per cent; also that for every inch of vacuum above 25 ins. or 26 ins., the consumption falls about 4 per cent.

Tests made on a 1000-kw. unit to determine the advantage of superheating, and the effect of varying the vacuum, showed a gain of about 12 per cent with 100° F. superheat, and an improvement in the steam economy of about 4 per cent per inch of vacuum.

Standardization of Extra-Heavy Pipe Fitting Flanges.—Several of the largest manufacturers of valve and pipe fittings last April sent representatives to a convention held in New York for the purpose of formulating standards for extra-heavy flanges. The delegates to the meeting appointed a committee to handle the details of the work, this committee consisting of J. C. Meloon, mechanical superintendent of the General Fire Extinguisher Company, Providence, R. I.; J. F. O'Brien, of the Pratt & Cady Company, Hartford, Conn.; L. R. Greene, of the Walworth Manufacturing Company, Boston, Mass.; H. D. Gordon, of Jenkins Brothers, New York; F. A. Strong, of Eaton, Cole & Burnham Company, Bridgeport, Conn., and F. A. Connet, of the Builders' Iron Foundry, Providence, R. I. Since its appointment the committee has had various sessions, and has finally submitted to the manufacturers interested in the matter the following recommendations and schedules for standard flanges:

1. Multiples of 4 for bolt holes.
2. Drilling to straddle the vertical axis.
3. Bolt-hole centers not to exceed 3⅝ ins., except in 2½-in. sizes. The committee at first proposed eight ⅝-in. bolts, but simple elbows and flanges were drilled together, and it was found that eight ⅝-in. bolts interfered with the insertion of the bolts.
4. The distance from the center of the bolt hole to the edge of the flange should always equal or exceed the diameter of the bolt plus ⅛ in. for 9-in. valves and under, and plus not less than ¼ in. for larger sizes.

Size of pipe. Inches.	Dia. of flange. Inches.	Thickness of flange. Inches.	Dia. of bolt circle. Inches.	No. of bolts.	Size of bolts. Inches.
2	6½	⅞	5	4	⅝
2½	7½	1	5⅞	4	¾
3	8¼	1⅛	6⅝	8	⅝
3½	9	1 3/16	7¼	8	⅝
4	10	1¼	7⅞	8	¾
4½	10½	1 5/16	8½	8	¾
5	11	1⅜	9¼	8	¾
6	12½	1 7/16	10⅝	12	¾
7	14	1½	11⅞	12	⅞
8	15	1⅝	13	12	⅞
9	16	1¾	14	12	⅞
10	17½	1⅞	15¼	16	⅞
12	20	2	17¾	16	⅞
14	22½	2⅛	20	20	⅞
15	23½	2 3/16	21	20	1
16	25	2¼	22½	20	1
18	27	2⅜	24½	24	1
20	29½	2½	26¾	24	1⅛
22	31½	2⅝	28¾	28	1⅛
24	34	2¾	31¼	28	1⅛

The bolt circle diameters, as above stated, will allow the use of calking recess on pipe flanges, provided such device is specified.

The schedule presented was unanimously adopted by the manufacturers present, and January 1, 1902, was the date set for adoption of same.

A limited number of the schedules will be printed by the committee, and copies can be obtained of the secretary, J. F. O'Brien, P. O. drawer 66, Station A, Hartford, Conn.

ESTABLISHED 1889.

American Electrician,

WITH WHICH IS INCORPORATED

Electrical Industries.

CECIL P. POOLE, Editor.
W. H. ONKEN, Jr., Associate Editor.

Published on the first of each month by the

American Electrician Company,

NEW YORK: 120 Liberty Street.
CHICAGO: Monadnock Block.
PHILADELPHIA: 929 Chestnut Street.
LONDON: Hastings House, Norfolk Street, Strand.

JAMES H. McGRAW, President.
A. E. CLIFFORD, Vice-President.
C. E. WHITTLESEY, Treasurer.
E. E. WOOD, Secretary.

Subscription, - $1.00 Per Year.

In the United States, Canada and Mexico.
FOREIGN COUNTRIES, $2.00.

NOTICE TO ADVERTISERS.

Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

IMPORTANT NOTICE.

Intending subscribers are warned not to place subscription orders with persons who cannot show written authority to take such subscriptions and make collections therefor, as the paper will not undertake to fill orders placed with alleged agents acting without such written authority.

Subscribers requesting a change of address should invariably furnish both the old and the new address.

Vol. XIII. NOVEMBER, 1901. No. 11

The American Electrician has a larger paid subscription list than any other electrical journal in the world.

CONTENTS.

The Steam and Electric Plant of a Graphite Factory 517
Neglected Heat Wastes, by R. A. Douglass 520
The Relation of the Rate of Evaporation to the Fuel Economy of Boilers, by William D. Ennis 521
Relative Merits of Open and Enclosed Arc Lamps for Street Illumination, by W. D'A. Ryan 522
Improvised Boosters, by Walter M. Hollis 524
Some Experiences and Results Derived from the Use of Highly Superheated Steam in Engines, by R. Lenke 525
A New Synchronizer, by Fred. P. Woodbury 527
Transverse Stresses in Steam Pipes, by A. S. Mann 528
Regulating Devices for Series Alternating-Current Circuits, by J. Henry Hallberg 529
American Street Railway Association 531
Abstracts from Foreign Contemporaries. 534
Some Recent Electrical Patents 538
Notes 538
Editorial 540
Design for 3-H.P. Launch Motor, by Cecil P. Poole 542
A Peculiar but Instructive Incident, by E. C. Parham 544
Modern Forms of Shaft Governor, by H. F. Schmidt 545
Lessons in Practical Electricity 548
Letters on Practical Subjects 549
Electrical Catechism 551
Queries and Answers 552
De Laval Steam Turbine 553
The Sperry Automobile Storage Battery. 554
New Apparatus and Appliances 555
Some of the Exhibits at the Street Railway Convention 558
New Books 561
Awards at the Pan-American Exposition 561
Legal Notes 563
Obituary 563
Personals 564
Trade Publications 564
Business News .... Adv. 35

The Nernst Lamp.

It is evident from the interesting information contained in the paper recently read by Mr. A. J. Wurts before the American Institute of Electrical Engineers that the reduction of the Nernst principle to actual lamps, operative on a commercial basis, has been one of the knottiest problems that have confronted electrical engineers since the incandescent lamp was brought to a satisfactory state. And notwithstanding the enormous difficulties that had to be and have been conquered, as well as the exhibition of Nernst lamps of commercial form in actual operation, one frequently hears pessimistic criticisms and predictions concerning this type. Those who feel dubious about the ultimate fate of the new lamp might be much encouraged by comparing some of the ancient arc lamps, which never by any possibility remained operative more than a month or two without repairs, with the product of the present day. But even conceding that the cases are not parallel, because the developers of the Nernst lamp have had advantages over the early builders of arc lamps on account of the advanced state of the art and the superior facilities now available, the prospect seems to us far from hopeless.

The disadvantages inherent in the lamp as it has been thus far developed are the deterioration of the glowers, the necessity for and deterioration of heaters, and the necessity for heater cut-outs and "ballast" resistances of special construction. The deterioration of the heater of the Nernst lamp is not due to its active service, which covers a period of less than a minute each time a lamp is lighted, but to its continued proximity to the glowers after they are started; the special construction employed in the cut-out magnet is required also because of its being subjected to much of the heat of the glowers. The glowers require renewal about every 900 hours and the heaters give out at about 2500 hours.

This does not sound so very much worse than enclosed-arc lamp practice, where expensive carbons must be renewed about every 150 hours; and the heater cut-outs and ballast resistances do not appear to be such a terrific incubus when one considers what is contained within the box of an arc lamp. In the Nernst lamp there is an electromagnet, the function of which is to open the heater circuit as soon as current passes through the glower, and an iron wire resistance coil enclosed in a tube with an inert gas; in the arc lamp, there is a considerable quantity of mechanism which *must* be very accurately adjusted in order for the lamp to operate, and a resistance coil, of the same material as in the first case but not enclosed with gas in a tube. The safety cut-out alone of an arc lamp is as complicated as the heater cut-out of a Nernst lamp, yet no one ever raised a calamity howl over the mechanical difficulties entailed by the cut-out of an arc lamp, nor even over the far more vulnerable carbon-controlling mechanism.

The foregoing approximate comparison of the Nernst lamp with the enclosed-arc lamp is by no means intended as an intimation that the latter is either objectionably complicated or in immediate danger of supercession by the newer type. We simply wish to point out that most of the criticisms that are fairly applicable to the Nernst lamp apply with equal or more force to the enclosed-arc lamp, which has never been considered commercially impractical since the proper kind of carbon was determined. The most serious obstacle in the path of the Nernst lamp is its first cost and the cost of glower renewals. Just here it may be remembered that incandescent lamps not so long ago sold for 75 cents each and gave an apologetic yellow glow for about 300 hours; also that lamp sockets at 60 cents each survived the strain of actual service about six months. As in the case of the arc lamp, this is not a strictly parallel case, because of the progress that has been made since the days of 75-cent incandescent lamps, but there is no reason to suppose that the case of the Nernst lamp is radically different from that of all other inventions—that it has come into industrial existence completely finished, Minerva-like, so that there can be no possibility of further improvement. If one should take this attitude it would be equivalent to saying that within the past two or three years the entire future progress of the art has been discounted and its resources exhausted.

◆

Series Alternating-Current Circuits.

The great improvement obtained by the enclosure of the source of light in an arc lamp was chiefly responsible, as most of our readers know, for the advancement of the alternating-current arc lamp from the status of dubious merit right up into the front ranks; the natural trend of progress in this field then turned toward series distribution, direct-current experience having shown this to be the best practice for street lighting, and the result is that series arc circuits are now almost as general in alternating-current as in direct-current practice. The flexibility of alternating current, however, has rendered it unnecessary to employ a distinct constant-current dynamo for arc-lighting service, some auxiliary or subordinate form of apparatus being sufficient to change constant potential into constant current and thus permit the restriction of the generating machinery to a single class. The summary of the methods used for thus regulating series circuits, which appears elsewhere in this issue, will doubtless be found interesting to central station men; not so much on account of the information concerning principles and connections as on account of the data relating to characteristics and limitations.

It is to be regretted that the discussion mentioned did not include the constant-current transformer of the "leakage" type having stationary coils, of which there are many in use. The results obtained with this type of transformer are somewhat similar to those shown by the moving-coil type. The power factor of the simpler form of apparatus, however, is lower at full load than that of the floating-coil type, but it does not fall off so rapidly with decreasing load, and the consequence is that the stationary-coil type does not regulate so closely as the other type, regulation being accomplished in both entirely by leakage. The current from the stationary-coil leakage transformer increases considerably as the load decreases, while with the moving-coil type the current is maintained practically constant.

Open and Enclosed Arcs for Street Lighting.

If any excuse were necessary for the frequent utterances on the above subject, a most adequate one is found in the lamentable fact that the average human mind thoroughly realizes and appreciates an engineering principle only after the most insistent reiteration of that principle. However, the latest contribution to the discussion of open and enclosed arcs, which appears on another page, is by no means restricted to reiteration. One of the very interesting points that has not been brought out in print heretofore is the great difference between the variation of the light from an open arc and that of the light given out by an enclosed arc after the arc is struck and before the lamp feeds, and also during the interval between any two feeding points. The variation immediately following the initial striking of the arc is not highly important; only the most unreasonable and stupidly arbitrary city official could raise any objection to the preliminary lack of light due to cold carbons and a short "strike."

The superiority of small units over large ones for street illumination has been recognized to some extent for several years, but we do not recall any previous experimental determination of the relative efficiencies that has been carried out quite so practically and with such a degree of definiteness as has that of Mr. Ryan. Another point that has been vaguely realized by some but has never been crystallized into a concrete precept is that the advantage obtainable by the use of small units does not extend to incandescent lamps, so far as street lighting is concerned, for the reason that it is not economically possible to illuminate to a sufficient height above the ground or with a sufficient degree of brilliancy by means of this type of lamp. The results obtained by Mr. Luther Stieringer at the Pan-American Exposition afford an example of the magnificent effects that are possible by the use of incandescent lamps—and plenty of money—but even this display, as superb an object lesson in decorative and special lighting as it was, could not be considered a refutation of Mr. Ryan's statement.

Phase.

At very frequent intervals we receive requests for a definition of the term "phase," and as it will be many months before the Lessons Department will reach alternating current phenomena, the following explanation will probably be welcomed by those of our readers who are unfamiliar with the subject.

An alternating e.m.f. rises from zero to maximum in one direction, drops back to zero, reverses and rises to maximum in the opposite direction, returns to zero again, and so on. Consequently, the current acts in the same manner. Now if two alternating e.m.fs. or two alternating currents rise to their maximum strength in the same direction (positive or negative) at precisely the same instant, they are said to have identical phases; if they do not, they are "out of phase," or there is a "difference of phase." Similarly, if an alternating current does not attain its maximum strength at the same instant that the e.m.f. of the circuit does, the current and e.m.f. have different "phases."

The extent to which two or more e.m.fs. or currents, or both, differ in phase with each other is measured in degrees of a circle, purely for mathematical convenience and not because there is anything circular or angular or otherwise geometrical about the actual phenomena. One cycle is considered as being divided into 360 degrees, and two currents having a phase difference of a quarter of a cycle are referred to as being out of phase "90 degrees," or being "90 degrees apart." Thus a two-phase generator delivers two distinct e.m.fs. which are 90 degrees apart in phase, one e.m.f. being at zero when the other is at maximum, and if the two circuits are loaded alike in every particular the two currents will also have a phase difference of 90 degrees.

When an e.m.f. and a current, or two e.m.fs., or two currents, are not expected to be in phase with each other, it is said that there is a "phase difference" of so many degrees. When the two are normally expected to rise and fall precisely together, if they do not, then there is said to be a "lag in phase" of so many degrees. Thus, in the case of a two-phase generator, one current would not be said to "lag" behind the other in phase, because the difference in phase is intentional and inherent. But in the case of an e.m.f. and a current in the same circuit, any difference of phase is referred to as a "lag" or a "lead," as the case may be, of so many degrees.

The term "phase" is also applied, for lack of a better one, to the parts of a polyphase circuit. A two-phase line consists usually of two distinct circuits, and it has become common practice to refer to each of these as a "phase," which is, of course, wholly inaccurate. Polyphase generators are rated at so many amperes and volts "per phase," and the designation was naturally extended to the line circuits, so that one speaks of so much load in each "phase," meaning the load in each monophase part of the composite circuit. The word "division" would be much more appropriate to use in speaking of the two parts of a two-phase or the three parts of a three-phase distribution system; the application of the term phase in this sense can easily become confusing.

DESIGN FOR 3-H. P. LAUNCH MOTOR.

BY CECIL P. POOLE.

The accompanying sketches show the salient features of a 3-h.p. multipolar motor designed particularly for driving the screw propeller of a small pleasure boat, say 14 to 16 ft. long. The field-magnet structure, which is shown by Fig. 1, is of cast steel, with six radial poles, the cross-section of each of which is of the shape and dimensions shown by Fig. 5. The poles have slots cored in them in the process of casting, 1¾ ins. wide, and extending from within ½ in. of the pole-face clear back to the circle of the yoke ring, and passing, of course, clear through the poles axially. The object in coring out these slots is mainly to reduce the weight of the machine, although an incidental advantage in the distribution of magnetic flux in the air-gap also results. The yoke ring is of the short barrel type, the contour of its cross-section being perfectly rectangular, as indicated in Fig. 2. The edges of the yoke ring must be trued up at the same time that the pole-faces are bored out, and a shallow recess turned up on the outside of the yoke for a distance of ¼ in. from each edge, as shown in Fig. 2. The object of this is to provide a seat for each of the end caps perfectly concentric with the bore of the pole-faces. The motor rests on two bracket feet cast integral with the yoke ring, as indicated in Fig. 1. In mounting the machine in a boat it is contemplated that these brackets will rest on small wooden sills parallel with the shaft of the machine, and bolted to the framing of the boat.

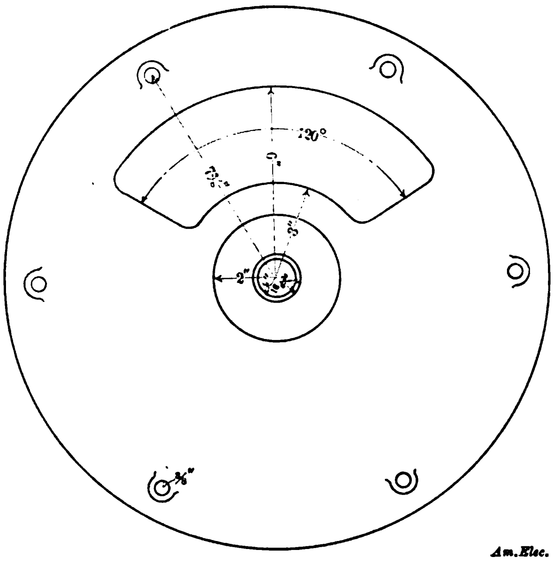
The armature core, core drum and shaft are illustrated by Fig. 7, which is almost self-explanatory. The core drum, *d*, is of cast iron, with a hub and head at one end, and the armature discs *a* are clamped in place by a clamping plate, *c*, at the other end, similar to the head of the core drum. The clamping plate is drawn into place by means of four bolts extending through it and tapping into the head of the core drum. It is centered by a circular rib fitting into a recess in the interior of the open end of the drum. Both the core drum head and the clamping plate carry circular projections or barrels, *b b*, for the purpose of supporting the armature winding, which is of the straight-out type. The armature discs should be keyed to the core drum, a very small key sufficing for this purpose, as the discs must be very tightly compressed by the clamping ring, and this will transmit considerable torque from them to the shaft. The hub of the armature core drum must, of course, be keyed to the shaft, and it is preferable to also key the hub of the clamping plate, *c*, to the shaft in order to avoid any twisting stress in the body of the core drum. The armature discs must have 46 slots 11/32 in. wide and 1 1/16 ins. deep, the slots being simply rectangular, as shown in Fig. 9, which is a cross-section of a single slot and the wires within it.

The armature core discs are 10 13/16 ins. in diameter, and the hole through the center is 6⅛ ins. in diameter. The length of the armature core parallel with the shaft when compressed into permanent shape must be precisely 3¼ ins. The outer diameter of the drum must, of course, fit the central hole of the armature disc, and its length, parallel with the shaft, is 3¼ ins. The inner diameter of the drum is 5¼ ins. The maximum diameter of the coil-supporting barrels, *b b*, is 8⅝ ins., this diameter being next to the core discs. The diameter of the barrels at their outer edges is 8⅜ ins., and their face measurement, parallel to the shaft, is 2 ins. The thickness of the clamping plate, *c*, is ⅜ in., and the thickness of the drum head is the same. The thickness of the coil-supporting barrels, *b b*, tapers from ½ in. maximum to ⅛ in. at the edges. The hubs of both the core drum and the clamping plate taper from 3 ins. to 2½ ins. in diameter, and are 2 ins. in length measured clear through. The bore of the hub, *h*, is 1¼ ins., and it is counterbored to a depth of ⅛ in. and a diameter of 1½ ins. The object of this counterbore is merely to have a true face for the shoulder of the shaft to butt against without involving the work of machining the entire inner surface of the drum head. The clamping plate, *c*, it will be noticed, is provided with a projecting ridge fitting into a counterbore or recess in the open end of the drum. This ridge need not be more than ¼ in. deep, its function being merely to center the clamping plate. The dimensions of the various parts of the shaft are as follows:

	r	s	t	u
Diameter, ins........	1⅛	1½	1¼	1⅛
Length, ins..........	7	5⅝	6⅝	4

The shaft is intended to be coupled to the propeller shaft by means of a plain flange coupling.

The journal boxes are cast integral with the enclosing caps of the field magnet.



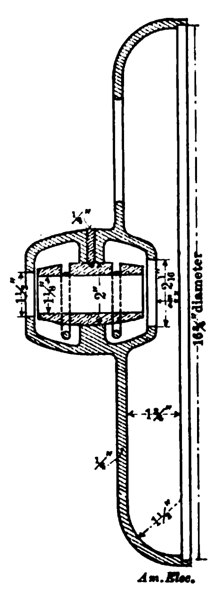
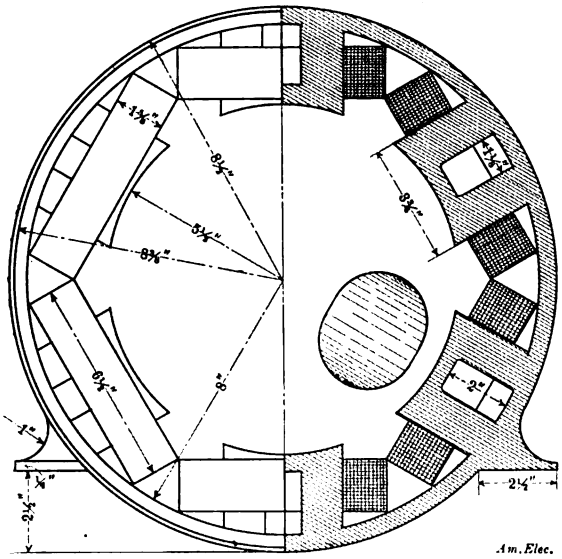


FIG. 3.—FACE AND SECTIONAL VIEW OF END CAP.—FIG. 4.



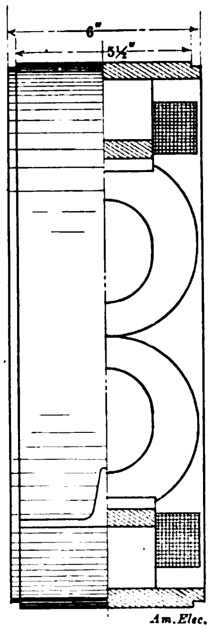


FIG. 1.—SEMI-SECTIONAL SIDE AND EDGE VIEW OF FIELD MAGNET.—FIG. 2.

Figs. 3 and 12 are face views of these caps, and Figs. 4 and 11 are cross-sections of them. It will be noticed that one of the enclosing caps has a circular extension chamber in the center; this is for the accommodation of the commutator and brushes. The journals are self-oiling, but of the wick-feed type in preference to the usual oil ring or roller form of feed. The wick feed is suggested for the reason that the pitching or rolling of the boat is likely to interfere with the operation of an oil ring by jamming it.

The commutator is not shown, it being considered inadvisable for an amateur to attempt the construction of this most vulnerable part of the machine. A finished commutator can be bought from any one of the various manufacturers for less money than it would actually cost an amateur to build one, and there is no comparison between the results. There must be 46 segments, and the commutator barrel must be 6 ins. in diameter, with an available brush tread or face 3½ ins. wide, measured parallel with the shaft. The total length of the commutator parallel with the shaft must not exceed 5 ins. The connecting lugs must be of such length as to give a diameter of 10¾ ins., measured from tip to tip of diametrically opposite lugs.

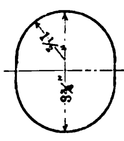


FIG. 5.

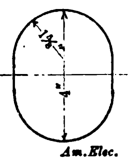


FIG. 6.

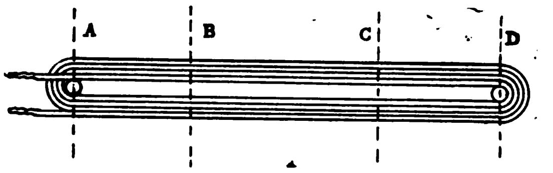


FIG. 8.—COIL BEFORE SHAPING.

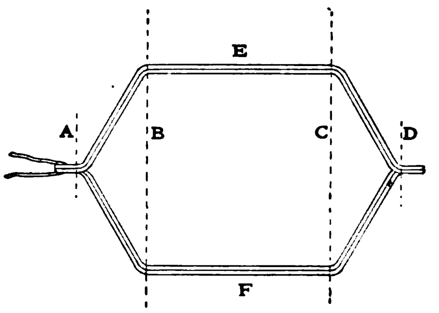


FIG. 10.—SHAPED COIL.

The machine is designed for the use of two sets of carbon brushes, two brushes per set; each brush must be ¾ in. thick by 1½ ins. wide, so that the total contact surface at each set of brushes will be 2¼ sq. ins. The builder can use his own judgment as to the type of brush-holder to be used, but should remember that it is absolutely necessary to have a reliable contact of low resistance between each brush and its holder. The two sets of brushes should be mounted precisely 60° apart. An opening is cored in the upper wall of the commutator chamber, through which access to the brushes may be had without removing the end cap; this opening may be normally closed by a cover conforming to the circular outline of the chamber.

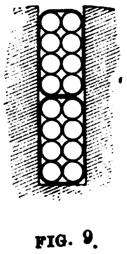


FIG. 9.

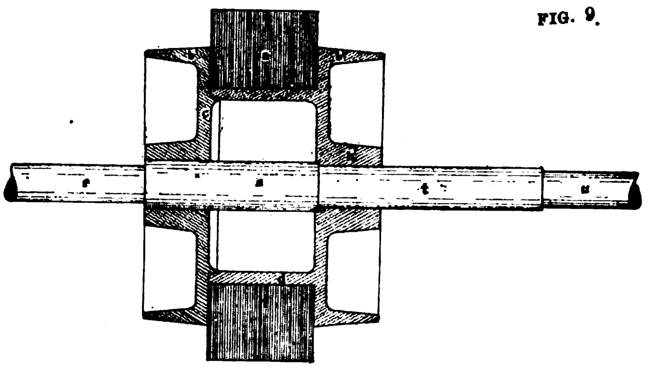


FIG. 7.—SHAFT AND SECTION OF ARMATURE CORE.

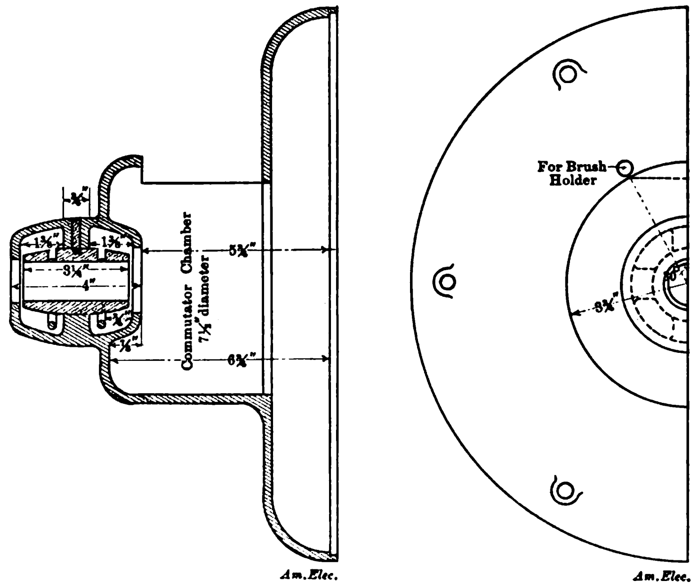


FIG. 11.—SECTIONAL AND FACE VIEW OF COMMUTATOR END CAP.—FIG. 12.

The armature winding of the machine is of the two-path type, and comprises 46 coils of No. 10 double cotton-covered magnet wire, wound two strands in parallel, with four turns per coil. The two strands in parallel should be wound side by side, so that a cross-section of the finished coil will show two wires in width and four in depth, as indicated in Fig. 9, which shows one of the armature slots with two half coils. The coils should be wound around two ⅝-in. pegs, located 9 3/16 ins. apart, as indicated in Fig. 8, which is a side view of a coil wound on the pegs, ready to be formed. The illustration shows only one wire, as the two wires are side by side. The convolutions of the coils should be secured with fine linen thread at each of the bends, *A* and *D*, and also at the two points indicated by the lines *B* and *C*. The distance from *A* to *B*, and from *C* to *D*, is 3 1/32 ins., the distance from *B* to *C* being 3¾ ins. Then the bends of the coil should be clamped from the points *A* and *D*, outward, leaving the two stretches of wire unclamped inside of the centers of the bend. Then each stretch or side of the coil should be held in a clamp, with long jaws, extending from *B* to *C*, one clamp being applied to the upper stretch and one to the lower stretch of wires, and the two sides should be pulled in opposite directions until a plan view of the coil resembles Fig. 10. Then it should be carefully covered with one wrapping of German linen tape, each layer being wound with a half lap, so that there will be two thicknesses of tape over the wires. Varnish the tape thoroughly and bake the coil until it is entirely dry.

The coils must be assembled on the armature core so that there will be 8 teeth between each side, *E* and *F*, Fig. 10. The coils must be put on the core with one side of each coil in its slot and the other side held temporarily above the core, successive coils being slipped under those already in slots until one side of every coil is in its slot and each coil is resting on the armature core on the other side. Then the other sides can be entered in the proper slots. When the coils are all in place in the slots they should be secured temporarily by two retaining bands of twine wrapped around the core under each end. Then the terminals should be carried to the commutator, all of the under terminals being put in first. The left-hand terminal of each coil should be carried to the left and the right-hand terminal to the right, as near equal distances as possible, the two terminals entering commutator segments, between which there must be 14 other commutator segments; this is true of every coil.

After the ends have been soldered in, a binding of No. 19 tinned iron wire should be put around the center of the core, being wound on an insulating strip of vulcanized fiber 1/64 in. thick; another binding of either strong cord or thin brass wire should be put around the projecting ends of the coils, about midway between the end of the armature core and the extreme end of the coil projections. These binding wires must also be wound on fiber strips 1/64 in. thick.

The field winding consists of No. 3

double cotton-covered magnet wire, each coil containing 35 turns; there should be 5 layers, with 7 turns in each layer. The coil should be wound on a forming block, the cross-section of which must have the shape and dimensions shown by Fig. 6. After winding the coil on the forming block it should be tied at all four corners with linen thread, in order to hold the wires in place while the coil is being removed from the forming block and during the operation of taping. After removing the block the coil must be insulated with two wrappings of German linen tape wound with a half lap, exactly like the armature coils were covered, the exterior being heavily varnished after the taping is completed. After varnishing, the coil should be baked until it is thoroughly dry. The six field coils are connected up in series in the usual manner to give alternate north and south poles, and the entire field winding is connected in series with the armature, making the machine a simple series-wound motor; speed regulation being obtained by changing the connections of the batteries supplying current to the motor.

◆

A PECULIAR BUT INSTRUCTIVE INCIDENT.

BY E. C. PARHAM.

Anyone accustomed to street railway work knows, of course, of the difference that a poor ground return will make in the heat, light and power furnished by the trolley wire. A loose or broken bond wire will render a car unable to start, because the current cannot get back through the ground return. The "peculiar incident" herein cited has to do with a broken bond wire. The circumstances surrounding the case were these: sometimes the shop motor would run, and sometimes it would not; at such times as the motor refused to run, it was found to be impossible to start a car on the section of trolley wire that fed the motor. At times the shop motor would stop, for no apparent reason, and in the course of a short while would start up again. At last, it was noticed that a transfer table that ran across the house and connected the front tracks to the rear ones, was in some way mixed up with the peculiar action of the shop motor. When the transfer table was far down in the corner of the shed, where it was usually kept when not in use, the shop motor would start and run all right, and cars could be started in any part of the house, but moving the transfer table would shut the shop motor down and kill the rear end of the house, unless the table had a car on it, in which case the shop motor would not stop until the car was run off the table. Moreover, it was sometimes the case that when the motor was shut down it would start up as soon as a car was run on the table from the rear of the house, and would shut down again as soon as the car passed off the table.

The accompanying diagram will help to explain these unusual actions; in this diagram, *T* is the trolley wire, *A* is the armature of the shop motor, and *F* is its field; *R* is the run-way for the transfer table; *S* represents three of the tracks in the rear of the house, and *S'* those in front; *B*, *B*, etc., are bond wires; *x* is also a bond wire. The sketch shows only three tracks, but there were fifteen in the house. All the tracks in the front of the house were bonded together, as were all of those in the rear, and the two sets of bond wires were connected through the single cable bond, *x*. This bond coming loose was what caused all of the trouble; with this bond broken, the rear section of the car house could get no return connection. The two sections, *a'*, *b'*, of the No. 1 track were a little closer together at the ends than the other tracks were, and when the iron table stood down in that corner it wedged in between the two sections and connected them electrically, thereby providing a ground for the rear end. The two transfer rails, *t*, were bonded together on the end, and this bond also connected to bond *x*, as shown in the diagram; *x* was open at the point indicated by the cross. When a car ran up on the table from the rear section, its iron truck would bridge the opening in *x*, being in multiple with it, and the motor would start as soon as the front wheels of the car touched the table. On one of the tracks, not shown in the diagram, the shop motor would keep on running as long as the car stayed on the table, because the weight of the car pressed the table down until it touched the unevenly sawed edge of the rear rail. On all of the other tracks the motor would stop as soon as both pairs of car wheels got on to the table, because then the car truck no longer acted as a bridge from the rear section of the track to the table.

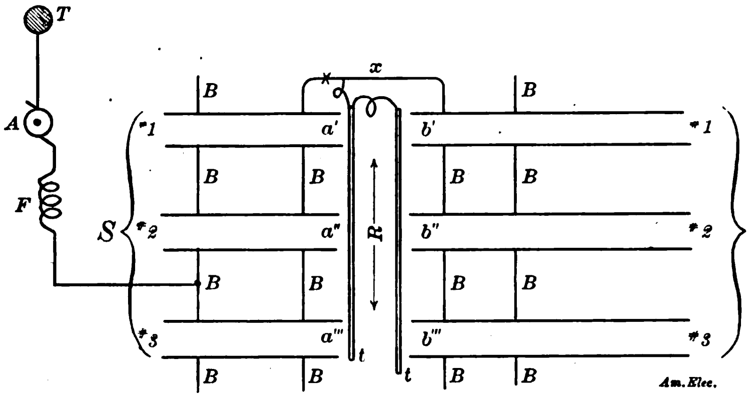


FIG. 1.—DIAGRAM OF CONNECTIONS.

The trouble only lasted a day or two, when a car of the rear section happened to start up about the same time that a car rolled off the transfer table onto the rear section, and the heavy flash made as the rear wheels left the table attracted the attention of a shop man. The flash caused by breaking the light current of the shop motor would not have been sufficient, perhaps, to attract the attention of anyone even who saw it, but the heavy current due to a car starting at the same time as the one on the table started made a display that there could be no mistake about.

For such a state of things to have kept on for any length of time would have been dangerous, as was demonstrated by the fact that one accident was narrowly averted during the short time that it did last. One of the men working on a controller went off and left the power drum on the first notch. When he left the car the rear section was dead, but while he was gone a car ran up on the table and gave the rear section a ground, and the car with the controller on the first notch started off; fortunately it was stopped before it could do any damage. It seems strange that no one working around the table should have gotten a shock to remind them that something was wrong with the rail return, but such a thing did not happen, although the lamps were turned on in several of the cars on the rear section, and it would have been only necessary to step on the table and on one of the rear rails at the same time. This gives one an idea of the trouble that might be entailed by allowing the bond wires of a road to get in bad shape. One bond cut in the right place might cause a greater drop in voltage than the drop in the entire trolley wire.

◆

Distinction for the British Fire Prevention Committee.— Edwin O. Sachs, chairman of the British Fire Prevention Committee, advises us that a large silver portrait medal accorded by Her Majesty, the German Empress, in connection with the fire congress of June last, has just been presented to the executive of the committee as a mark of appreciation for the services rendered by that body in the demonstration of scientific and economic aspects of fire protection. It may be remembered that a deputation of the committee, comprising Mr. Sachs, Ellis Marsland, F. R. Farrow and C. E. Goad, accompanied by the secretary and engineer, visited Berlin in the summer, and that an important exhibit of technical models and photographs was loaned to the German authorities for the exhibition held in connection with the congress.

MODERN FORMS OF SHAFT GOVERNOR.

BY H. F. SCHMIDT.

The shaft governor, as a result of its very general application owing to the demand for close speed regulation in high-speed engines, is to be met with in modern practice in a number of diversified constructions. In the various commercial applications details have been worked out in widely differing and very interesting forms, while the principles involved differ very little. There are two general classes of shaft governor in use, the plain centrifugal governor and those in which both centrifugal force and the force of inertia in a tangential direction are utilized in one mechanism. The centrifugal shaft governor is so called because the governing action of causing the changing of the position of the eccentric is set up by the centrifugal force acting in weights pivoted on the governor wheel so as to move radially thereupon. The other type of shaft governor, the so-called "inertia" governor, depends upon the inertia of weights pivoted upon the governor wheel to shift the eccentric for slight variations in speed, the inertia effect being preceded by centrifugal effect, which places the inertia weights into the most effective position for responding to the speed variations.

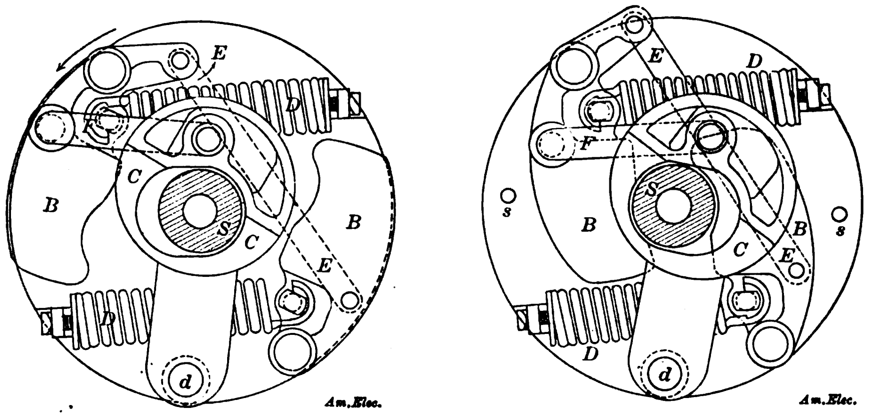


FIG. 1.—WESTINGHOUSE GOVERNOR.– FIG. 2.

A representative form of the centrifugal shaft governor is to be found in the governor used in the Westinghouse Standard engine, of which outline drawings are shown in Figs. 1 and 2. Fig. 1 shows the governor mechanism in its position when running at full speed, and Fig. 2 shows it when idle. As may be readily seen, the two weights, *B B*, are pivoted so as to be capable of movement in radial lines outward from the shaft. They are opposed in such movement by the heavy springs, *D D*, which tend to hold them up against the shaft, *S*. As the engine gets into motion and approaches full speed the weights move gradually outward, due to centrifugal force, from their idle position to that shown in Fig. 1. This motion of the weights serves, through the linkages, *E E*, and *F*, to shift the position of the eccentric *C* (the arm of which is pivoted at *d*), so as to produce the requisite governing effects at the valves. As the eccentric is drawn to the left across the shaft, its center is brought nearer to and farther around the center of the shaft, thereby decreasing the valve travel and at the same time increasing the angular advance. The effect of this increase of angular advance with the shorter valve travel is the well-known feature of earlier cut-off without altering the point of admission, which is the principal advantage of automatic cut-off governing.

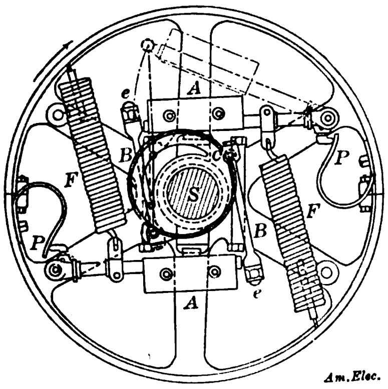


FIG. 3.—BUCKEYE GOVERNOR.

In Fig. 3 is shown a view of the centrifugal shaft governor used upon the engines made by the Buckeye Engine Company, Salem, Ohio. It may be readily seen to resemble the type previously shown. The weights, *A A*, act against the force of the springs, *F F*, when the wheel is up to speed. and their movement causes, through the agency of the links, *B B*, the eccentric, *C*, to rotate around the shaft, *S*, which accomplishes the desired regulating effect at the valve. The auxiliary springs, *P P*, are introduced to act on the arms in opposition to the main springs *F F*, so as to afford closer regulation with light and varying loads. These springs act only during the inner half of the range of movement of the arms, being thus out of contact with them during the outer range of positions.

In Fig. 4 is shown a type of governor somewhat similar to those previously mentioned; this form of governor is used on the engines of the Erie Iron Works, Erie, Pa. The weights, *W W*, are pivoted in the usual way so as to separate in opposition to the force of the spring, *S*, when actuated by centrifugal force. The spring is connected to one arm only, the other weight being constrained by being connected to the projecting arm, *L*, of the first weight by a wire rope, *C*, which plays around the sheave, *H*. The wire rope is positively clamped to the sheave, of course, and a square button fitting in a slot in an auxiliary eccentric sleeve transmits the motion of the sheave to this eccentric, which in turn moves the main eccentric across the shaft, thereby varying the travel of the valve and consequently the port opening. By means of the screw, *P*, the movement of the weights, *W W*, may be varied and thus the speed of the engine changed.

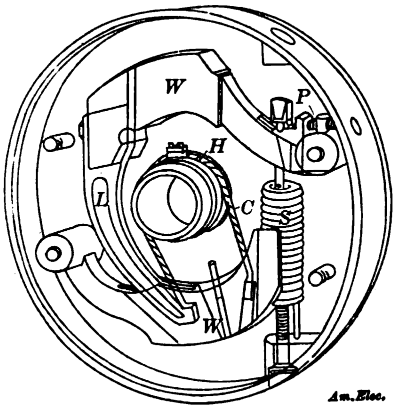


FIG. 4.—ERIE IRON WORKS GOVERNOR.

Fig. 5 shows the type of governor used on the engine built by the Straight Line Engine Company, of Syracuse, N. Y. In this governor there is only a single centrifugal weight, *W*, the action of which is opposed by a flat leaf spring instead of coil springs, as in the previous types. The end of the spring is connected with the weight by a thin steel band, *B*, which always touches the weight at the same distance from the pivot of the weight arm, because of the arc-shaped surface of the extension on the right of the weight to which the band is attached. As in the types illustrated by Figs. 1, 2 and 4, this governor shifts the eccentric across the shaft, altering the angular position of its major axis and also altering the travel of the valve. The eccentric plate is pivoted at *P*, its opposite end being linked to the governor weight arm, as clearly shown in the engraving. The weight, *W*, is hollow and filled with lead shot in order to make it heavier than it would be if

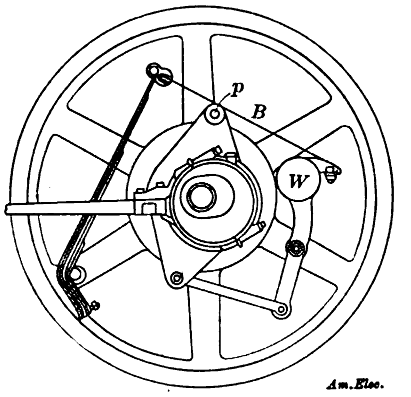


FIG. 5.—STRAIGHT LINE GOVERNOR.

cast solid of iron, and thereby increase the centrifugal force obtainable with a given size of weight.

Fig. 6 illustrates a governor almost exactly like the one just described, the chief differences being in the shape of the weight arm and in the method of connecting the leaf spring to the governor ball. A straight rod is used for this latter purpose in place of the flexible steel band employed on the Straight Line governor. This governor is also equipped with the dash-pot to steady its action and avoid pumping; it is used on the engines of the Noye Manufacturing Company, Buffalo, N. Y.

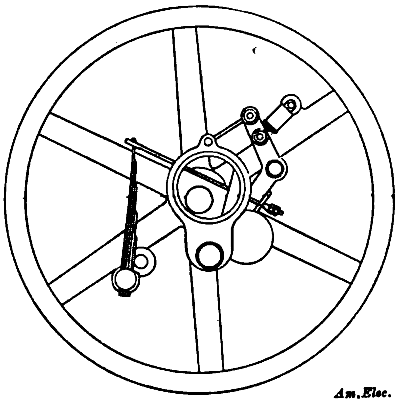
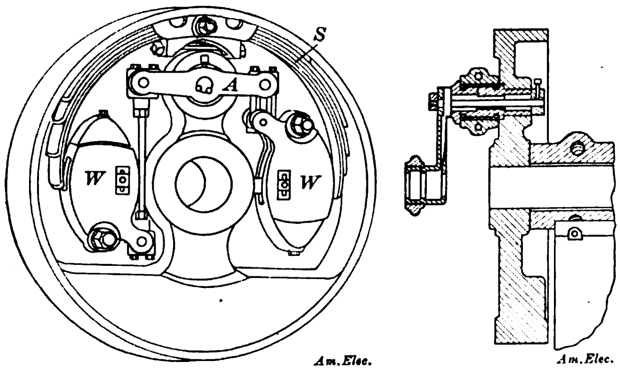

Am. Elec.

FIG. 6. NOYE GOVERNOR.

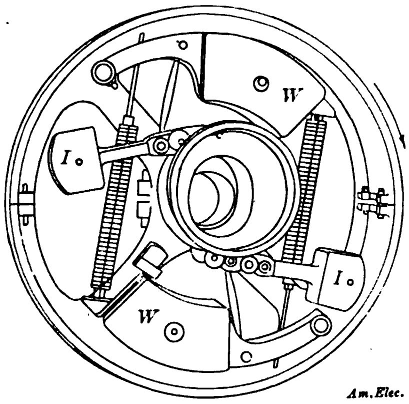
Figs. 7-a and 7-b illustrate a peculiar type of governor gear employed in the Rice automatic engine, built by the John T. Noye Manufacturing Company, Buffalo, N. Y. The governor weights, *W W*, are linked to a rocker arm, *A*, in such manner that the outward movement of the weights throws the right-hand end of the arm downward and the left-hand end up, rotating the spindle to which the arm is keyed. The influence of centrifugal force is opposed by a double leaf spring, as plainly shown in the engraving. The spindle or shaft to which the rocker arm, *A*, is keyed, passes through the center of the crank-pin, the governor being housed on the rear side of the crank disc. Fig. 7-b is a cross-section of the crank-pin and disc, showing this arrangement. The rock shaft carries on its outer end a crank, the free end of which is near the center of the engine shaft and carries a hollow wrist-pin to which the valve rod is attached. The movement of the weights rocks the shaft in one direction or the other, altering the distance of the valve-rod wrist-pin from the center of the engine shaft, and thus changing the throw of the valve.



Am. Elec. Am. Elec.

FIG. 7-A.—RICE GOVERNOR —FIG. 7-B.

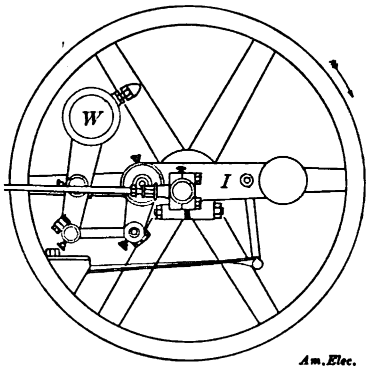
The second class of governor mentioned in the introductory paragraph may be properly divided into two sub-classes, one of which contains two distinct sets of controlling members, one set being influenced chiefly by centrifugal force and the other chiefly by the inertia of the weights. Fig. 8 illustrates a governor of this type which is built by the Fitchburg Steam Engine Company, Fitchburg, Mass. The weights, *W W*, are thrown outward by centrifugal force and their movement is restrained by coiled springs in exactly the same manner as in the case of the Westinghouse governor first mentioned. The auxiliary weights, *I I*, are affected in a tangential direction by their own inertia. When the shaft begins to revolve the eccentric is in the position shown in the illustration, which is the position of maximum throw, but as the speed increases the weights, *W W*, move outward, swinging the eccentric across the shaft and reducing its throw. At normal speed the centrifugal force of the weights is balanced by the springs when they are in such a position that the arms carrying the weights, *I I*, are in an almost radial position, making the whole mechanism very sensitive to the influence of inertia in these weights. While the engine is running under this condition any change in speed causes a movement in the opposite direction of the weights *I* and *I*, which results in shifting the valve in the proper direction to counteract the change in speed. For example, with the engine running at normal speed any slight check in speed will result in the inertia weights, *I* and *I*, being carried forward at the previous rate of motion for a short distance, opening the valve and causing the engine to resume almost instantaneously its normal speed.



Am. Elec.

FIG. 8.-FITCHBURG GOVERNOR

Fig. 9 illustrates the governor used by the Reeves Machine Company, Trenton, N. J., in which the same principles are utilized as in the Fitchburg governor, the only differences being structural. In this case there is only one centrifugal weight, *W*, and one inertia weight, *I*. The levers carrying the two weights are linked together, and the action of centrifugal force is opposed by a single leaf spring. Here the arm carrying the inertia weight is truly radial, so that the weight is extremely sensitive to changes of speed. Instead of an eccentric a wrist pin is mounted on the arm of the inertia weight and serves as a crank pin to reciprocate the valve rod, the throw being altered by the movement of the inertia-weight arm across the center of the shaft.

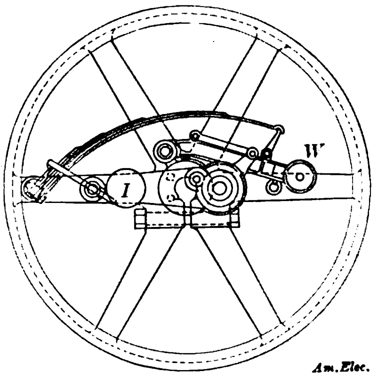


Am. Elec.

FIG. 9.—REEVES GOVERNOR.

A governor very similar to the Reeves is that used by the Ball & Wood Company, New York, and illustrated by Fig. 10. In this governor the weight, *W*, which is acted upon chiefly by centrifugal force, is pivoted in such a manner that the inertia of the ball also comes into play and assists the action of the inertia weight, *I*. A leaf spring like those used in the forms previously described is here used, but the spring is curved instead of straight. A point claimed for this governor is that the pressure of the spring is applied to the governor mechanism in such manner that no unnecessary pressure is brought upon the suspension pin.

Fig. 11 shows a governor in which combined effects of inertia and centrifugal force are also used, but in which the centrifugal and inertia weights are both mounted on the same lever. This governor has the duplex system of levers, springs, etc., the governor being absolutely symmetrical on both sides of the



Am. Elec.

FIG. 10.—BALL & WOOD GOVERNOR.

shaft, as in the case of some of the simple centrifugal governors mentioned in the foregoing paragraphs. The large weights in the engraving are the centrifugal weights, and the small ones those moved chiefly by inertia. An eccentric is used in connection with this governor, the eccentric being shifted across the shaft as in some of the cases previously mentioned. This governor forms part of the Ideal engine, built by the Harrisburg Foundry & Machine Company, Harrisburg, Pa.

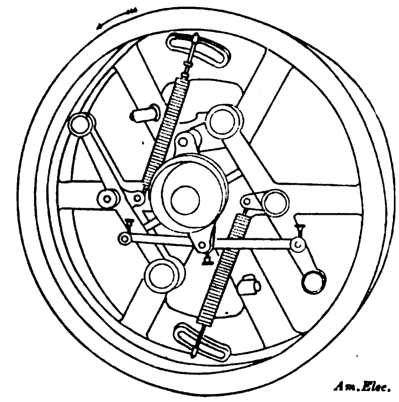

Am. Elec.

FIG. 11.—HARRISBURG GOVERNOR.

The Skinner Engine Company, Erie, Pa., uses the form of combined centrifugal and inertia governor illustrated by Fig. 12. This governor is built on practically the same principles as the Harrisburg governor, except that only a single weight bar is used instead of the duplex arrangement, and the weights are somewhat peculiarly arranged. Both of the larger weights are moved mainly by centrifugal force and the smaller weight by inertia. A wrist pin is used to drive the valve rod, as in the case of the Rice and Reeves governors. The bar carrying the weights is mounted on a roller bearing for the purpose, of course, of reducing the friction to the lowest degree.

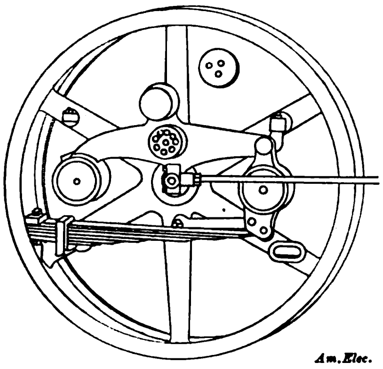
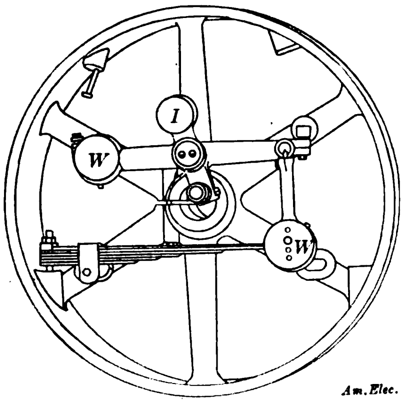

Am. Elec.

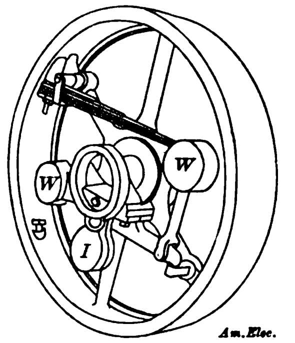
FIG. 12.—SKINNER GOVERNOR.



Am. Elec.

FIG. 13.—SHEPHERD GOVERNOR.

Fig. 13 shows the Shepherd governor used by the American Fire Engine Company, Seneca Falls, N. Y., which is almost identical with the Skinner governor, the differences being that the auxiliary arm carrying the weight, *W*, is connected to the main weight bar by a knife edge bearing instead of a pin, and the leaf spring attachment is a trifle different. The governor used by the Erie City Iron Works, Erie City, Pa., and illustrated by Fig. 14, differs from the two previously mentioned chiefly in the use of an eccentric instead of a wrist pin for imparting motion to the valve rod.



Am. Elec.

FIG. 14.—ERIE CITY GOVERNOR.

The next step in simplification consists of the use of only a simple weight bar carrying an inertia weight at one end and a centrifugal weight at the other end and linked to the eccentric. Such a governor is used by the American Ball Engine Company, Bound Brook, N. J., and illustrated by Fig. 15. In this governor the valve rod is attached to a wrist-pin instead of an eccentric, the pin being mounted on a plate which is rotated about a pivot set eccentrically as to the engine shaft. This rotation is accomplished by means of the linkage to the weight bar, as shown in the engraving. The restraining spring is attached to the weight bar in such a manner, according to the manufacturer, that practically no pressure is applied to the suspension pin, so that the sensitiveness of action is increased. The movement of the wrist-pin to which the valve rod is attached is such that the throw of the valve and the angular advance of the wrist-pin with reference to the main crank-pin are varied simultaneously, the variations being proportioned so as to keep the lead and compression nearly constant for all changes of cut-off.

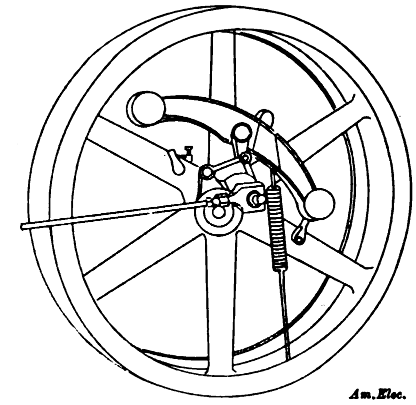
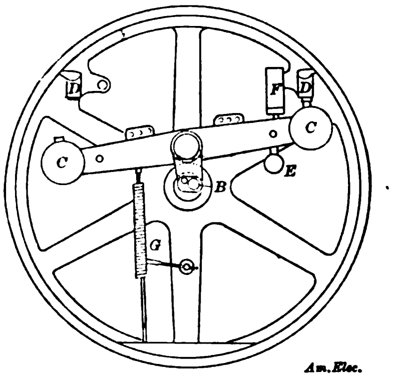

Am. Elec.

FIG. 15.—AMERICAN BALL GOVERNOR

The governor illustrated by Fig. 16 represents one more step in simplification, namely, the elimination of the linkage between the weight bar and the valve rod wrist pin. In this governor the wrist pin is attached directly to a lug extending at right angles from the weight bar. This governor is practically the simplest form of the Rites type, and is so sensitive in operation that a dash-pot is added to give it stability. The end of the short arm carrying the valve rod wrist pin is slotted to permit finer adjustment of the valve. This governor is applied to the McEwen engine, built by the Ridgway Dynamo & Engine Company, Ridgway, Pa.



Am. Elec.

FIG. 16.—MC EWEN GOVERNOR.

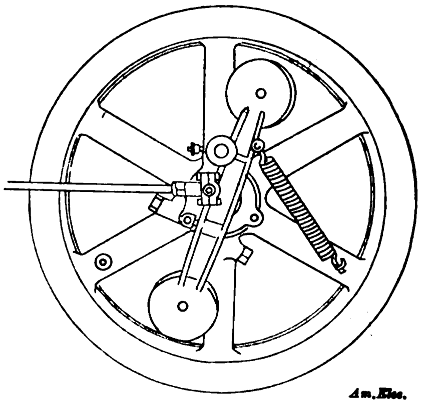

Am. Elec.

FIG. 17.—PAYNE GOVERNOR.

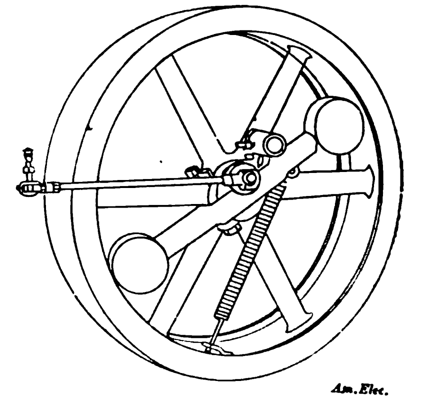

Am. Elec.

FIG. 18.—AMES GOVERNOR.

Figs. 17 and 18 illustrate governors so

nearly like the McEwen governor as to be practically identical, the only difference between these and the McEwen being the relative location of the weight bar pivot and the valve-rod wrist-pin. The governor illustrated by Fig. 17 is used on the engine of the Payne Company, Elmira, N. Y., and that shown in Fig. 18 is used by the Ames Iron Works, Oswego, N. Y. These two are substantially identical, there being only a slight difference in the point at which the outer end of the coiled spring is attached to the flywheel and a corresponding difference in the angle of pull.

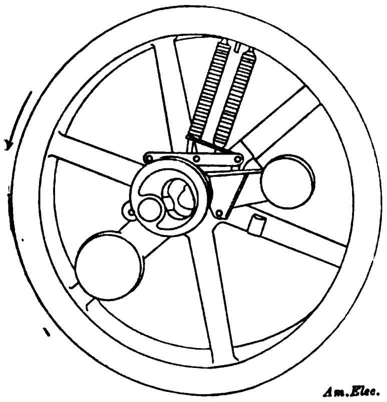


FIG. 19.—ERIE BALL GOVERNOR.

Two governors very similar to these last two are those of the Ball Engine Company, Erie, Pa., illustrated by Fig. 19, and the Westinghouse Machine Company, Pittsburg, Pa., illustrated by Fig. 20. The Erie Ball governor differs from those last described chiefly in the use of an eccentric instead of a wrist pin and the manner of attaching the restraining spring to the weight bar. The Westinghouse governor differs from the Payne and Ames governors mainly in the use of an eccentric instead of a wrist pin, the spring suspension being practically the same. In both the Westinghouse and Ball governors the eccentric is shifted across the shaft and its angle of lead is varied simultaneously. This form of governor is used by the Westinghouse company on its compound engines.

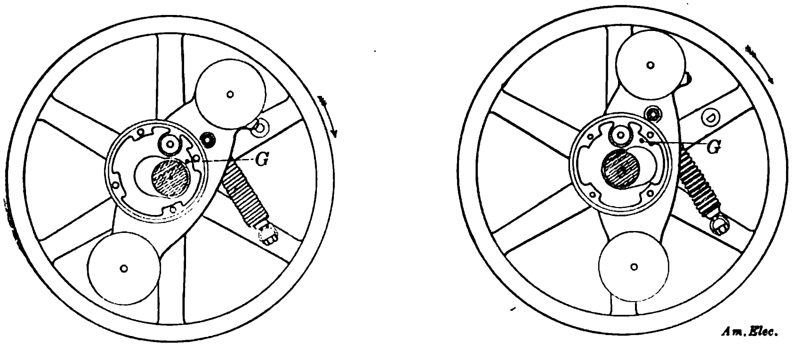


FIG. 20.—WESTINGHOUSE COMPOUND GOVERNOR.

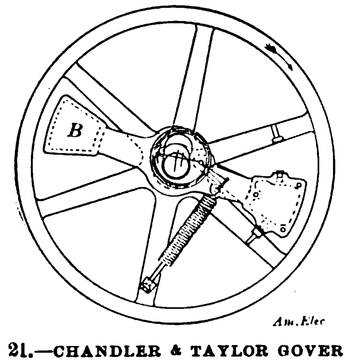


FIG. 21.—CHANDLER & TAYLOR GOVERNOR.

Figs. 21 and 22 illustrate two governors which are practically identical with each other and very similar to the Westinghouse compound engine governor. A perfectly straight weight-bar is used in both with a massive weight at each end, and the eccentric is integral with the bar, near its center, the motion of the bar being such as to shift the eccentric across the shaft and vary its angular lead. The governor illustrated by Fig. 21 is used by the Chandler & Taylor Company, Indianapolis, Ind., and that shown by Fig. 22 is used by James Leffel & Co., Springfield, Ohio, on their automatic Class B engines.

Lessons in Practical Electricity

ELECTROMAGNETISM.

When current passes along a conductor there is set up a magnetic force the direction of which is along a curved path concentric to the conductor, as represented in Fig. 1, where the inner circle represents the end of a round conductor and the outer circle indicates the general direction of the force. This force produces a "magnetic field" about the conductor which is said to consist of a "magnetic flux"; the value of the flux is measured in "lines of force." The magnetic field occupies all the space about the conductor and extends parallel with it throughout its length; the strength of the magnetic force, and consequently the strength or intensity of the resulting magnetic field, at any point, is directly proportional to the strength of the current in the conductor, and inversely proportional to the distance of the point from the center of the conductor. The exact strength of the magnetic force at any distance from the conductor is found by multiplying the distance by 12.7 and dividing the current by the result.*

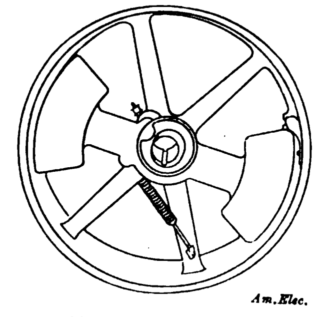


FIG. 22.—LEFFEL GOVERNOR.

In Fig. 2 the concentric rings about the conductor are made of different thicknesses, to indicate the relative field strengths at the different distances from the conductor, the distances being taken from the center of the conductor to the centers of the respective bands. The center of the first band, for example, is ¼ in. from the conductor center, and its thickness is ¼ in.; the second band is twice the distance away and has one-half of the thickness, indicating a field of one-half the intensity, and so on. Of course, the field is not divided up into magnetic bands of definite width with free spaces between; the diminution of magnetic strength is extremely gradual, and every square unit of path cross-section contains magnetic flux. The diagram is a purely arbitrary device to indicate the differences of field strength at different distances and not the dimensional disposition of lines of force.

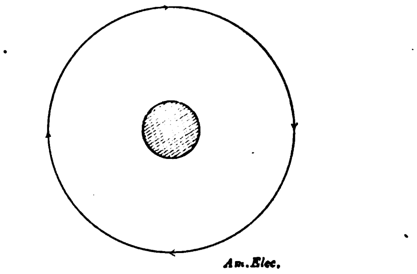


FIG. 1.

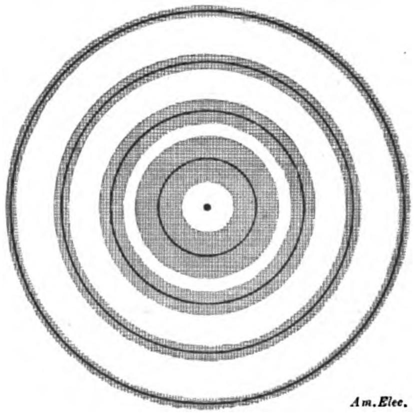


FIG. 2.—RELATIVE FIELD STRENGTHS.

The direction of magnetic force about a straight conductor is clock-wise when the current in the conductor is flowing from the end of the wire at which one is looking. In Fig. 3, the current is supposed to be flowing from left to right in the straight wire, and if one looked squarely at the left-hand end of the wire, holding

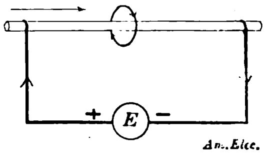


FIG. 3.

---

*Representing the current in amperes by *C*, the distance from the conductor in centimeters by d_m and the distance in inches by *d*,

$.2C \div d_m =$ magnetic force.

$d_m = 2.54d.$

$.2C \div d_m = .2C \div 2.54d = C \div 12.7d.$

it straight out in front of one's face, the direction of the magnetic force would be clock-wise around the wire, as indicated by the circle and arrow-head. The circle, *E*, represents any source of e.m.f. See also Fig. 1.

Now, if the conductor be bent into ring shape, the circular lines of force will continue in their path around each unit length of the conductor, so that all of them will thread through the ring in the same direction, each completing its "circuit" around the outside, as indicated roughly in Fig. 4. Here the course of the total flux is represented by single circles a considerable distance from each other and from the wire, but it must be borne steadfastly in mind that the "lines of force" of a magnetic field of appreciable strength are packed close together —in fact, that the field is not actually divided up into individual lines as a rope is divided into threads; the term "line" was used by Faraday purely for convenience in expressing the strength of magnetism and the direction of magnetic force. With the conductor bent into the form of a ring, as in Fig. 4, the *whole* area enclosed by the ring will be threaded by lines of force or magnetic flux. The strength of the magnetic force within the ring will vary similarly to that about a straight conductor, being weakest at the center of the circle, which is the point farthest from the wire, and strongest right at the edge of the wire. The force at the center is equal to π times the current divided by 12.7 times the mean radius of the ring, or $\pi C \div 12.7d$. The force at any other point cannot be expressed in simple algebra.

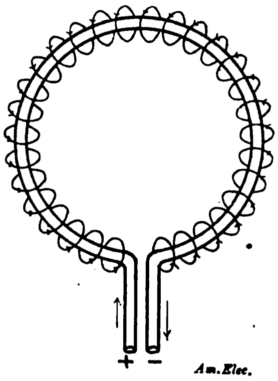


FIG. 4.—LINES OF FORCE.

Letters on Practical Subjects

A Problem in Bell Wiring.

To the Editor, American Electrician;

Sir:—I enclose a solution (Fig. 1), of the "Problem in Bell Wiring" given on page 508 of the October issue. While the problem is an interesting one, anyone familiar with electric bell diagrams should have little trouble in working it out.

H. W. Korhammer.

Shrewsbury, Mo.

[The same solution was sent in by Messrs. Chas. H. Coar, Eveleth, Minn.; C. J. Drees, Little Rock, Ark.; Fred. G. Dustin, Minneapolis, Minn.; J. A. Fottler, Bayside, R. I.; Joel Gomborow, Philadelphia; P. A. Gould, Saranac Lake, N. Y.; L. S. Little, Springfield, Ohio; Wm. A. Loveland, Wilmington, Del.; B. W. Marshall, St. Louis, Mo.; John J. Marshall, San Francisco; Geo. M. Ockford, Jr., Ridgewood, N. J.; Lewis C. Reynolds, New York; Howard F. Shepherd, Colorado Springs, Colo.; A. Westervelt, New York; G. H. Wright, Danvers, Mass., and Roy E. Young, Quincy, Mich. This plan of wiring agree with the original of Mr. Schuhmann.—Editor.]

To the Editor, American Electrician;

Sir:—Enclosed is a solution of Mr. A. Schuhmann's "Problem in Bell Wiring," published in the October number. The details of wiring would depend, of course, on the relative location of the four offices.

Arthur B. Smith.

Missouri Valley, Iowa.

To the Editor, American Electrician;

Sir:—Enclosed is a solution of Mr. Schuhmann's "Problem in Bell Wiring." The push-buttons are connected in the common way shown, each group of buttons having one common wire and individual wires. The three buttons in each office have one side connected to a common wire which goes to the drop corresponding with the number of the office, and from the drop to one side of the battery. One side of the bottom row of drops is connected to the other side of the battery, and a section wire is carried from the other side of each drop to all three offices, the three buttons corresponding to each drop being tapped to the section wire from that drop.

New York. Leslie E. Carpenter.

To the Editor, American Electrician;

Sir:—I send herewith a diagram which I think meets all the requirements of the "Problem in Bell Wiring," by Mr. Schuhmann, in the October number.

Rochester, N. Y. G. Weber.

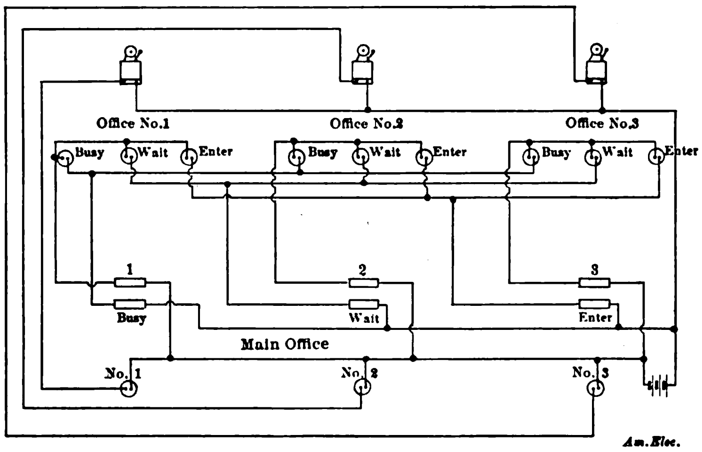
To the Editor, American Electrician;

Sir:—I enclose a diagram of a solution of the bell-wiring puzzle appearing on page 508 of the October issue. The problem simplifies itself into two sets of circuits; one calling circuit operated from the main office, and independent annunciator circuits operated from the private offices.

John R. Pusnell.

Washington, D. C.

[All of the last four letters refer to Fig. 2. This solution of the problem was also sent in by Messrs. Frank R. Addis, Allentown, Pa.; Harry P. Bennett, Concord, N. H.; M. L. Carr, Peoria, Ill.; Wm. Christensen, Belmont, Mass.; J. W. Coakley, Chicago; E. S. Cole, New York; K. B. Davis, Middletown, Ind.; Oliver C. Dennis, Chicago; Jas. B. Dillon, Louisville, Ky.; Herbert W. Drake, Buffalo, N. Y.; Wm. A. Evans, Philadelphia; P. C. Fish, St. Louis; Edwin R. Fisk, Pittsfield, Mass.; G. H. Gneiss, Chicago; J. H. Hamilton, Philadelphia; C. R. Hayes, Worcester, Mass.; John B. Hayes, Buffalo, N. Y.; A. G. Hemmings, Schenectady, N. Y.; P. J. Hoff, New York; I. Jarcho, New York; S. M. Karicofe, Bement, Ill.; E. L. Kennedy, Buffalo, N. Y.; R. M. Kittson, Roxbury, Mass.; David Loree, Somerville, N. J.; L. R. McDonald, Montreal, Canada; C. C. McMahon, Chattanooga, Tenn.; Kenneth G. Moffatt, Maple Creek, Canada; Chas. Morrison, San Mateo, Cal.; Frank A. Pim, Seattle, Wash.; Geo. R. Renfree, Philadelphia; Wm. F. Schneider, Oak Cliff, Tex.; S. E. Smith, Cleveland, Ohio; A. H. Teale, Brooklyn, N. Y.; Frank W. Thompson, New Haven, Conn.; O. C. Thompson, New Albany, Ind.; J. M. Tib-



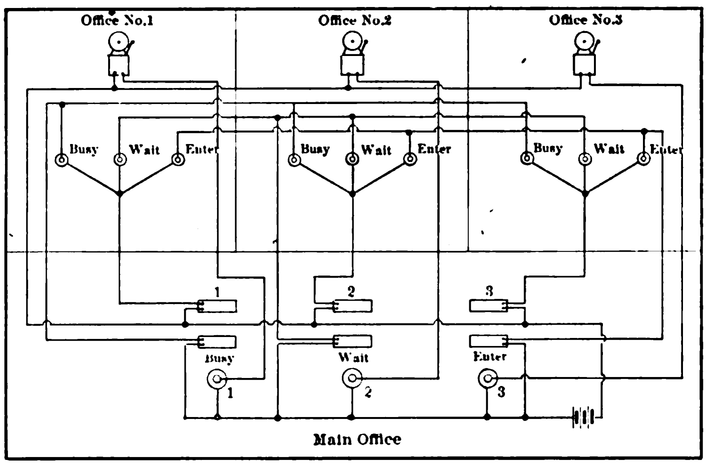


FIG. 1.—SOLUTIONS TO BELL WIRING PROBLEM.—FIG. 2.

bals, Kansas City, Mo.; Chas. T. Vought, Bloomfield, N. J.; H. E. Wadsworth, Brooklyn, N. Y.; J. M. Walker, Newcastle, Pa.; H. A. Weir, Morristown, N. J.; J. P. Welsh, Eau Claire, Wis.; Chas. E. Werner, New York; W. Howard Williams. Camden, N. J., and C. R. Wylie, Saginaw, Mich.

This diagram solves the problem fully as well as Fig. 1, which is the plan specified by the author. The only difference between the two is that in Fig. 1 the common-return wire of the main office pushes and that of the numbered drops go to one side of the battery, while the common-return of the bells and that of the "busy," "wait" and "enter" drops go to the other side of the battery; whereas, in Fig. 2 the common-return of the main office pushes and that of the "busy," "wait" and "enter" drops are connected to the same side of the battery, while the common-returns of the numbered drops and the bells go to the other side of the battery.—Editor.]

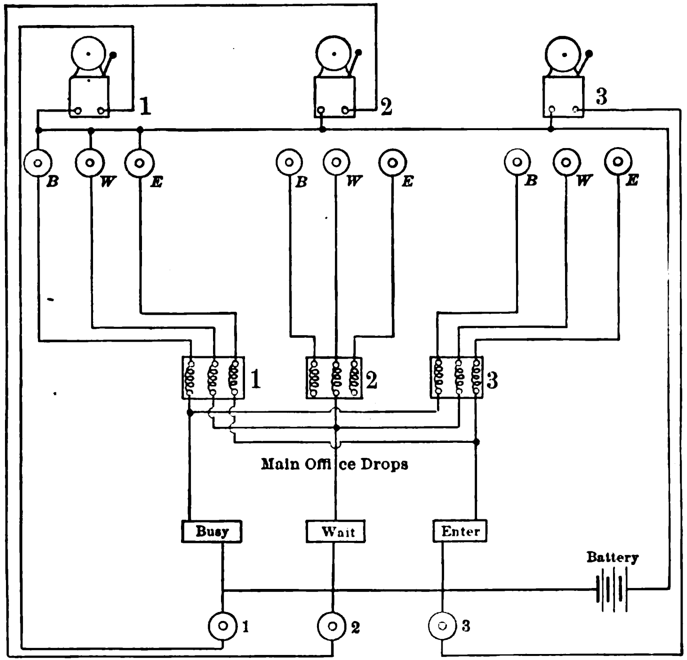


FIG. 3.—J. H. HAMILTON'S SOLUTION.

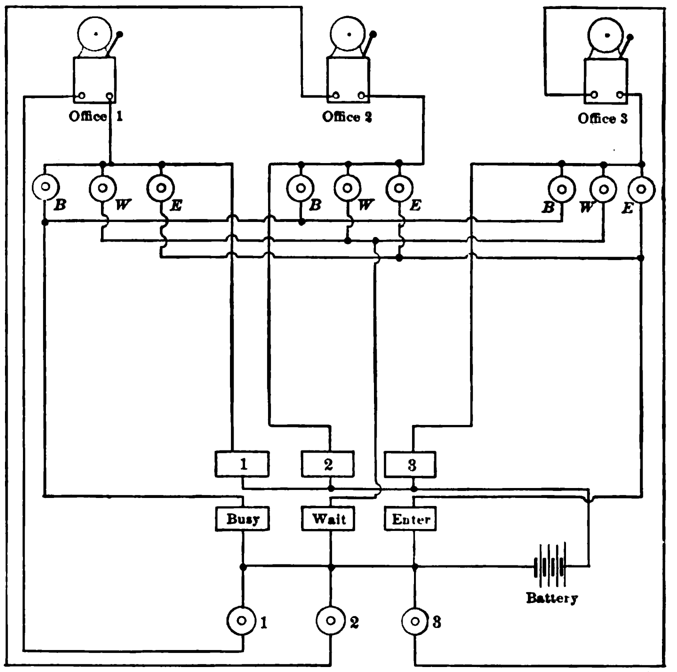


FIG. 4.—G. W. MALCOLM'S SOLUTION.

To the Editor, American Electrician;

Sir:—I send herewith a diagram of connections which I think will meet the requirements of Mr. Schuhmann's "Problem in Bell Wiring," published in the October issue. Mr. Schuhmann said nothing about the type of annunciator to be used, so I took the liberty of using a special design to fit the case. Each of the numbered drops is actuated by a magnet having three distinct windings; one connected between the "busy" push in one of the private offices and the "busy" drop in the general office; the second winding connected between one of the "wait" pushes and the "wait" drop; and the third winding connected between one of the "enter" pushes and the "enter" drop. In other respects the diagram is practically self-explanatory.

John H. Hamilton.

Philadelphia, Pa.

To the Editor, American Electrician;

Sir:—Referring to Mr. Schuhmann's "Problem in Bell Wiring," which appeared in the October number of this paper, I submit the enclosed diagram (Fig. 4) as a solution. All of the main office pushes and the "busy," "wait," and "enter" drops are connected on one side to a common battery wire; the other side of each push goes to the bell which is to ring, of course, and each bell gets its return to the battery through the numbered drop of the annunciator which corresponds to the number of the bell. Consequently, pressing one of the main office pushes will ring the bell corresponding to its number, and also throw the drop in the main office corresponding to its number, thus giving an indication as to whether or not the circuit is good. If it should be preferred, the right-hand binding posts of the three bells could be connected to a common return carried down to the positive side of the main battery instead of being connected individually to the common wire of the "busy," "wait" and "enter" push buttons of each office. This would, of course, make the bells ring more strongly, but it would necessitate running ten wires from the main office to the private office instead of nine.

George W. Malcolm.

Brooklyn, N. Y.

Central Station Methods.

To the Editor, American Electrician;

Sir:—I would like to have the opinions of station managers and superintendents on some points of central station work concerning which there seems to be no set rule. In the first place, what should be charged to investment or capital stock of a central station company after the plant is installed in operation? Should transformers, meters, new poles, lines, etc., added during operation be charged to investment or to running expenses? What percentage of the total cost of the plant should be charged off each year for depreciation due to wear and the usual losses in the way of burned-out meters, transformers, etc., that have to be replaced by new apparatus. For example, if a station loses an armature by being burned out, would a new winding or armature be charged to investment or expense?

I should also like to have opinions as to the proper method of keeping station reports and getting at the actual cost per kilowatt-hour of the energy distributed. Our minimum charge for wattmeters is $1.00 a month, but we are considering charging $2.00 as the minimum and not putting in any meter for less than six lamps. I should like to know what the practice is in this respect in other stations, and also what discount is allowed to large consumers. What is a fair rate per kilowatt-hour for service, and what would be an economical cost of production per kilowatt-hour under ordinary conditions with fuel at $3.00 a ton delivered at the furnace.

S. T. Webber,
Engineer, The People's Light, Heat and Power Company.
Salina, Kan.

Three-Wire Distribution from Rotary Converters.

To the Editor, American Electrician;

Sir:—I beg to call your attention to the last paragraph of your editorial in the October number on a "Remodeled Central Station" in which you state that "the amount of unbalancing permissible with the Atlanta arrangement is not so great as with alternating-current distribution supplied direct from the transformer, but it is ample for all practical purposes, and immensely preferable to the use of auxiliary machinery for balancing (or more accurately, to allow unbalancing)." This statement is somewhat misleading. As a matter of fact, connecting the neutral bus-bar to the center points of the secondaries of the lowering transformers allows of an unbalancing of 100 per cent, which, of course, is equal to what could be obtained by any system of distribution. This has been demonstrated in Atlanta by actual test. Chas. N. Black.

New York.

[The editorial comment referred to might advantageously have been made more explicit by stipulating "equally satisfactory regulation" as the basis of comparison between the Atlanta system and a three-wire transformer system. This is what was meant. The question is largely academic, however, as the difference in regulation cannot be serious and the arrangement under discussion obviously allows as much unbalancing, with satisfactory regulation, as would ever be required on a properly designed system, such as the one at Atlanta.—Editor.]

Electrical Catechism

648. Why are zincs better when amalgamated?

Commercial zinc is not chemically pure, but contains impurities, such as bits of iron, carbon and other substances. When the zinc is immersed in any liquid which attacks the zinc more than the impurities, an e.m.f. is set up; as the two substances are connected through the liquid and also through the metal, local currents ensue which eat away the zinc until the foreign substance is set free and falls away. When the zinc is amalgamated, that is, coated or alloyed with mercury, the mercury seems to cover up the impurities and to bring only the pure zinc to the surface. The smooth surface seems to hold a film of hydrogen when the cell is not at work, and this film seems to protect the zinc from attack when acid is present, and to protect it from local action at all times.

649. How are zincs amagamated?

A common way is to dip the zinc in dilute sulphuric acid, which cleans it thoroughly, and then to rub mercury over it with a swab until the zinc is uniformly bright all over. The swab may be simply a piece of cloth wrapped around a wooden stick. In some cases the zinc and mercury are cast into a sort of alloy or amalgam, the zinc being melted first and the mercury added.

650. What is the silver chloride cell?

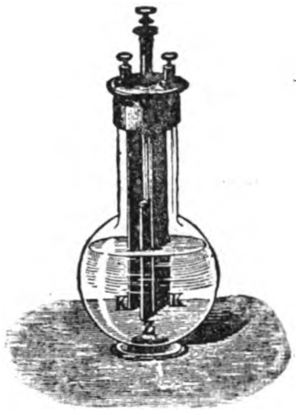
This cell uses a zinc rod for positive electrode. The negative consists of a silver rod surrounded by silver chloride, which is melted into a cylinder upon the rod. The electrolyte is a solution of sal ammoniac. When the cell generates current, the zinc displaces the chlorine in the sal ammoniac, and the ammonium thus set free displaces the chlorine in the silver chloride, leaving metallic silver deposits on the silver electrode. No gas is set free unless the cell is worked too hard. This cell gives about 1.1 volts and, being small and easily portable, is much used for testing purposes, and to some extent for medical purposes.

651. What are dry cells?

Dry cells are generally modifications of sal ammoniac cells, in which the water is largely replaced by some gelatinous substance of more or less secret composition. The original Gassner dry cell used a paste made of 1 part oxide of zinc, 1 of sal ammoniac, 3 of plaster, 1 of zinc chloride and 2 of water, all by weight. Dry cells are very convenient for portable use and in the hands of unskilled persons, but their useful life is generally much shorter than that of cells using solutions of sal ammoniac in water.

652. Why is it necessary to remove the zinc from some forms of open circuit battery when not in use?

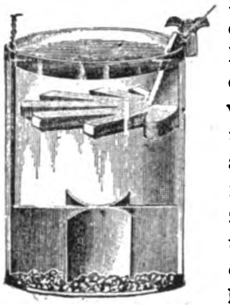
In some cells which use permanganate of potash or sulphuric acid in order to secure a high e.m.f., the electrolyte acts upon the zinc by ordinary chemical action, even when not delivering current; such cells are therefore provided with means for removing the zinc when not in use.



GRENET (PERMANGANATE) CELL.

653. What are closed circuit batteries?

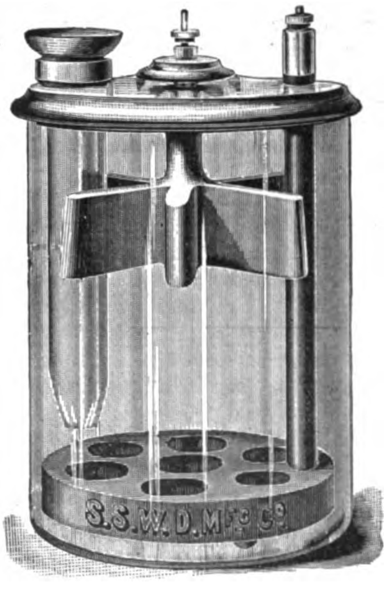
In closed circuit cells it is usually necessary to keep the circuit closed all of the time to prevent injurious action in the cell, as it is harmed more by standing idle than by use. The best known example of a closed circuit cell is the gravity, or "crowfoot" cell, used so largely for telegraph and fire alarm circuits. The zinc electrode is commonly cast in the form of a foot, which gives it the common name. The copper positive plate usually consists of several sheets of copper riveted together and to an insulated wire, which forms the terminal. Crystals of copper sulphate, often called "blue vitriol" or "blue stone," are placed in the bottom and the cell is filled with water. As the cell stands, the copper sulphate dissolves in the water and the solution rises higher and higher until it reaches the zinc, unless the circuit is closed, in which case the zinc is dissolved, forming zinc sulphate at the top of the cell, while copper is deposited from the blue solution upon the copper plates at the bottom. So long as the cell is working, there is a more or less distinct division between the two solutions, but if the cell is left on open circuit, the copper solution rises until it comes into contact with the zinc, where the copper deposits and a local action rapidly eats up the zinc and exhausts the solution. As the copper solution is heavier than the zinc, it tends to stay at the bottom of the cell, and gravity keeps the zinc and copper solutions apart when the cell is working. This gives it the name of "gravity cell."



CROWFOOT CELL.

654. Explain the action of the Bunsen cell.

The Bunsen cell contains a carbon plate in a cup of porous earthenware filled with strong nitric acid (HNO_3). The zinc is placed outside the porous cup in a jar filled with dilute sulphuric acid (H_2SO_4) made of about one part of acid to twelve of water. A number of molecules of the sulphuric acid (H_2SO_4), seem to be broken up into free hydrogen ions, H, and sulphions, SO_4. When the cell is in operation, the sulphions appear at the zinc anode and form zinc sulphate, $ZnSO_4$, while the hydrogen ions appear at the carbon cathode where they take part of the oxygen from the nitric acid to form water (H_2O) and leave nitrous acid (HNO_2), or hyponitrous acid (HNO); or, the hydrogen may even reduce the latter acid to nitric oxide (NO), which escapes as a very corrosive and objectionable gas. This cell gives about 1.8 volts.



PARTZ (BICHROMATE) CELL.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

What kind of battery and how many cells are necessary to operate the 6-in. spark coil described in the January, 1897, number? W. S. C.

Four or six cells of any good closed-circuit battery.

What is the relation between the resistance of platinum wire and that of ordinary copper wire. (2). What action has chlorine gas on platinum? J. M.

Platinum wire has approximately 5.7 times the resistance of copper wire. (2). Chlorine gas in its ordinary state has no effect; nascent chlorine attacks platinum, forming chloride of platinum.

What system of electric lighting and power is most liable to damage by lightning? G. P. K.

No complete metallic-circuit system is more liable than any other of the same class. A street-railway system using an overhead trolley and grounded track return is slightly more liable to lightning damage than any system in which the circuit is not grounded.

I have three generators all of one make, but one of different type from the other two, running in parallel. The last-named machine takes more than its share of the load at full load. How can this be remedied? H. A. T.

Connect a resistance coil of iron wire in between the equalizer terminal of the strong machine and the end of the series field winding which is now connected to that terminal. The size of wire to be used is given by the formula:

$$(75\ C)^2 = d^3,$$

in which *C* is the current that will pass through the coil, and *d* is the diameter of the wire in mils.

What size of resistance wire must be used for a submerged heating coil to take 9 amperes at 220 volts? C. E. F.

The smallest size advisable is given by the formula:

$$(5.5\ C)^2 = d^3,$$

in which *C* is the current, and *d* is the diameter of the wire in mils. This formula applies to galvanized iron wire, which is the kind that would preferably be used for such a coil. The formula may be expressed in words, thus: Multiply the current by 5.5, square the result, and take the cube root of the square; the final result will be the diameter of the wire in mils.

In silver plating with a silver anode, what solution is used? (2). What is the required voltage? (3). In starting gravity batteries is it of any advantage to add a spoonful of sulphuric acid? (4). Is a vacuum necessary in a wireless telegraph coherer for transmitting at short distances? J. M. F.

Double cyanide of silver and potassium, with a very slight trace of bisulphite of carbon. (2). The voltage depends upon the shape and size of the bath, and ranges from 6 to 10 volts. (3). No; the addition of sulphate of zinc is preferable. (4). The distance has no influence upon the question of vacuum. Vacuum is not strictly necessary in any coherer, but it is advisable, in order to prevent oxidization of the particles within the coherer.

In concealed knob and tube wiring, where no outlet boxes are used, how should fixture openings be fused? C. J. D.

The outlets cannot be fused individually without running an individual main from each outlet to the cabinet panelboard. The best plan is to combine several outlets on each main in such a way that the total current in each main will be about 6 amperes, and fuse the main at the panelboard for the whole group of lamps. If the distances are considerable and the number of lights per outlet 6 to 8, it will usually be found preferable to run an individual feeder for each outlet.

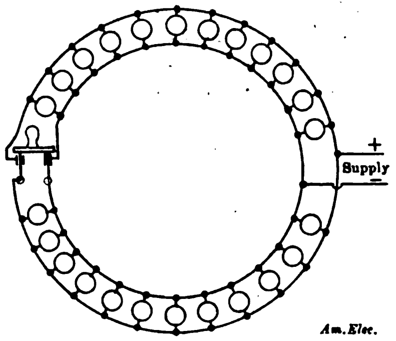


FIG. 1.

The enclosed sketch (Fig. 1) shows a complete ring main fed from one side and having a switch inserted in the opposite side of the ring; how can the lights be all switched in or out by means of the switch without adding any wires or changing the location of the switch? C. E. H.

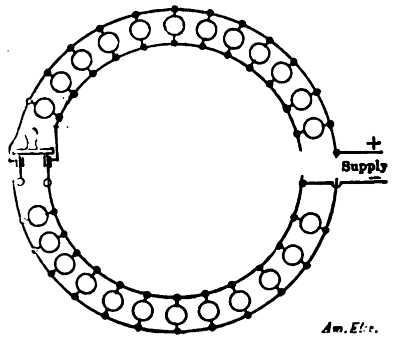


FIG. 2.

Cut the two wires forming the ring, in between the supply taps, as shown by Fig. 2.

How can the number of magnetic lines of force passing through a generator armature be calculated from the ampere-turns on the field magnet? F. C. Z.

In the case of a finished machine the amount of flux can be calculated by running the machine without load and applying the following formula:

$$\Phi = \frac{6{,}000{,}000{,}000 \times E}{Nw \times p.p.m.}$$

In this formula Φ represents the number of magnetic lines under one pole-piece, *E* is the voltage at the brushes, *Nw* is the total number of armature conductors all around the circumference, and *r.p.m.* is the revolutions per minute of the armature. The machine must be separately excited so that no current flows through the armature except the minute amount required by the voltmeter.

With an average voltmeter reading of 541 volts, an ammeter reading of 80 amperes, a generator efficiency of 92 per cent, and an engine efficiency of 82½ per cent, what indicated horse-power is required in the engine cylinder? C. H.

The electrical horse-power delivered is:

$$\frac{541 \times 86}{746} = 62.367 \text{ horse-power.}$$

The efficiency of the engine and generator combined is:

$$92 \times 82\tfrac{1}{2} = 75.9 \text{ per cent.}$$

Consequently the indicated horse-power must be:

$$\frac{62.367}{.759} = 82.17 \text{ horse-power.}$$

Please explain how the following problem is solved and the principles underlying such problems; the problem is to reduce:

$$\frac{8}{\sqrt{3} + \sqrt{2} + 1}$$

to a fraction having a rational denominator. (2). What is a rational denominator? B. T.

$\sqrt{3} = 1.732$; $\sqrt{2} = 1.414$; consequently the denominator reduces to $1.732 + 1.414 + 1 = 4.146$, so that the fraction can be written:

$$\frac{8}{4.146} \text{ or } \frac{4}{2.073}.$$

(2). The foregoing demonstration answers this question.

What is meant by "absolute" pressure? (2). In a boiler carrying steam at 80 lbs. pressure, as indicated by the gauge, what is the absolute pressure? (3). What is the pressure tending to burst a boiler when the steam gauge indicates 80 lbs.? R. M.

Absolute pressure is the total pressure exerted by steam or other vapor within an enclosed vessel. (2). The absolute pressure would be practically 94.7 lbs. The gauge indicates the net pressure, or the difference between the total steam pressure within the boiler and the pressure of the atmosphere on the outside. The pressure of the atmosphere is commonly taken at 14.7 lbs., which is near enough for practical purposes. (3). The pressure tending to burst a boiler is the net or gauge pressure.

What is the formula for the horse-power of a three-phase motor? (2). How can the power factor of a motor be measured? (3). How can the power of a three-phase circuit be measured by a single wattmeter? E. R. R.

$$\frac{E \times C \times p \times e}{430} = \text{horse-power at the pulley.}$$

In this formula *E* is the voltage from wire to wire of the supply line, *C* is the current in one wire, *p* is the power factor of the motor, and *e* is its efficiency. (2) Connect a wattmeter, voltmeter and ammeter to the same pair of wires and take the readings of all three simultaneously. Multiply the readings of the voltmeter and ammeter together and divide the wattmeter reading by the product. (3) If the circuit is balanced, as in the case of motor supply, connect the wattmeter to one pair of wires and multiply its reading by 3.

DE LAVAL STEAM TURBINE.

The latest development of the De Laval steam turbine is illustrated herewith, Fig. 1 being a general view of a 300-h.p. turbine, Fig. 2 a sectional view of one of the nozzles, Fig. 3 a sectional view of the governor gear, and Fig. 4 a section through the governor valve chamber. The De Laval turbine, as our readers doubtless know, is of the impact type, the steam being delivered to curved buckets on a wheel, as indicated in Fig. 2. In the latest form of the turbine the flexible shaft for allowing the bucket wheel to find its true position with regard to its center of gravity is retained. A spiral reducing gear is employed to bring the speed at the dynamo shaft down to one-tenth the rate of the bucket wheel, the speed of the latter ranging from 10,000 to 30,000 r.p.m., according to the size of the wheel; the velocity of the wheel buckets is about 1350 ft. per second. The reducing gear is enclosed in a drum-like casing, shown between the turbine and the dynamo in Fig. 1.

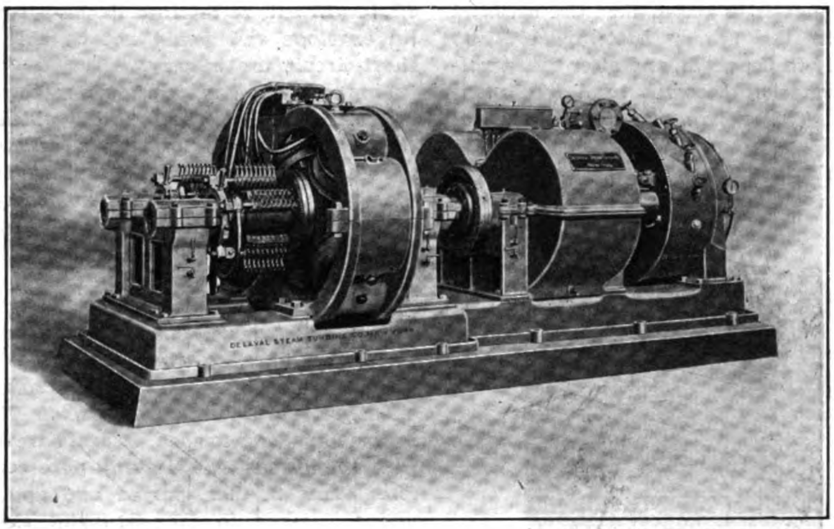


FIG. 1.--STEAM-TURBINE DYNAMO.

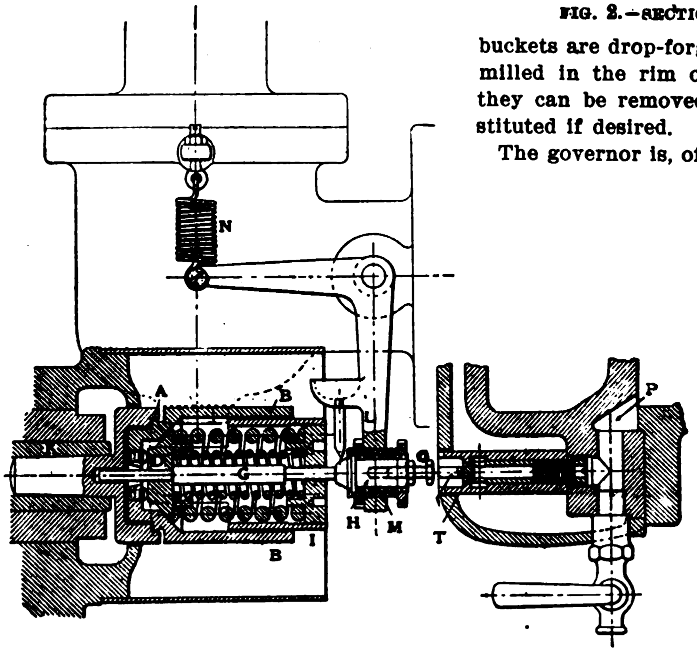


FIG. 3 —SECTIONAL VIEW OF GOVERNOR GEAR.

There are from one to twelve nozzles, according to the size of the turbine. In the multiple-nozzle machines each nozzle is provided with a stop valve, as shown in Fig. 2, so that under continuous light loads some of the nozzles may be shut off and the steam in the active nozzles used with but little throttling at the governor. The bucket wheel is made of forged nickel steel, in order to provide against trouble from the high peripheral velocity. The buckets are drop-forged and fitted to slots milled in the rim of the wheel, so that they can be removed and new ones substituted if desired.

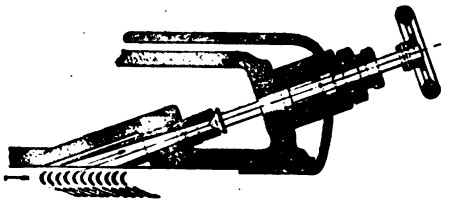


FIG. 2.—SECTION OF NOZZLE.

The governor is, of course, of the throttling type, and of extremely simple and compact design, as Fig. 3 indicates. The weights, *B B*, are substantially parallel with the shaft, and fulcrumed on knife-edges at *A A*. In the ends of the radial arms of the weights are hardened-steel pins, *C C*, having rounded heads which press against a hardened collar, *D*, mounted on the spindle, *G*, which actuates the throttle through the medium of the lever, *L*. The connection here is a little unusual. The spindle, *G*, carries on its outer end a plunger, *H*, which fits loosely in a cylinder screwed into the end of the lever, *L*, and imparts motion to the lever through a coil spring, *M*, which is so much stiffer than the restraining spring, *N*, that the connection is in effect rigid within the limits of the travel of the lever, *L*. When this lever is over to the right-hand end of its travel the governor valve is entirely closed, and the head, *O*, barely touches the head of the plunger, *T*. Now, in the event that the load has been suddenly thrown off, and the governor valve, although closed, fails to keep the speed within proper limits, because of the effect of the steam entrapped between the governor valve and the turbine wheel, the spindle, *G*, will be carried farther to the right, the plunger, *H*, moving independently of the now stationary arm, *L*, and the screw-head, *O*, will press the plunger, *T*, into its tube, opening the tube to the atmosphere and admitting air to the turbine-wheel chamber; the effect of this is to break the vacuum and reduce the speed. Of course the whole action is practically instantaneous, and is to guard against any momentary excess of speed due to the removal of load; the governor

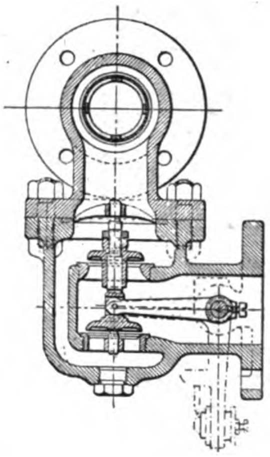


FIG. 4.—GOVERNOR VALVE CHAMBER.

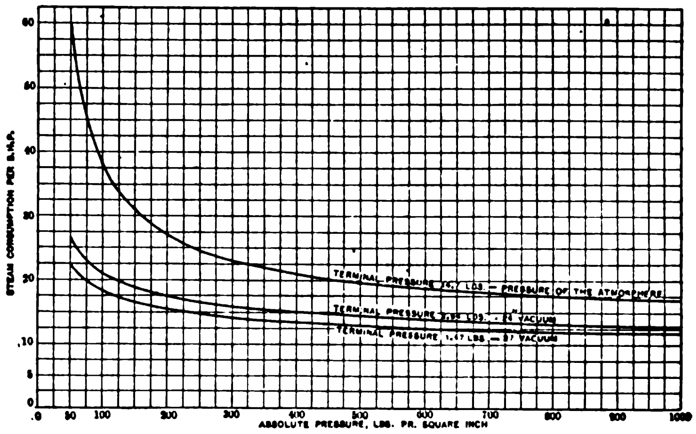


FIG. 5.—CHART SHOWING PERFORMANCE OF TURBINE.

valve would obviously prevent a continuation of excessive speed after the entrapped steam had passed through. The governor valve is of the balanced poppet type, as shown clearly in Fig. 4.

The American De Laval Steam Turbine Company, New York, builders of the turbine, states that a series of tests made on a 300-h.p. equipment gave the results shown by the accompanying table, and gives the chart, Fig. 5, as showing a representative performance of the turbine.

Tests of a De Laval Turbine.

Steam admission pressure in front of the jet nozzles in lbs. per sq. in.	Temperature of steam at admission valve, Fahr.	Vacuum at exhaust of turbine in inches mercury.	Number of jet nozzles open.	Number of revolutions per minute of the driving shafts.	Brake horse-power.	Steam consumption per hour and brake horse-power.
192.7	453.70	27.28	7	772	307.8	13.96 lbs.
196.3	437.	27.64	6	762	259.0	14.46 lbs.
196.3	440.6	27.56	5	767	219.9	14.20 lbs.
196.3	437.	27.64	4	775	175.0	14.29 lbs.
190.6	426.2	27.83	3	777	123.3	14.73 lbs.
196.3	390.2	28.07	2	775	75.2	17.02 lbs.
213.4	388.4	28.54	1	773	31.9	21.30 lbs.

The temperature of the steam on leaving the boiler was 734° Fahr. during the first test.

The length of the steam piping from the steam valve on the boiler to the admission valve of the turbine 318 ft. 6.83 ins.

Barometrical pressure in the engine room, 30.91 ins.

THE SPERRY AUTOMOBILE STORAGE BATTERY.

A considerable departure from the practice commonly followed in the construction and formation of storage battery plates of the Planté type has been made by the National Battery Company, of Buffalo, N. Y., of which Mr. Elmer A. Sperry is the engineer. The Sperry grid, illustrated by Fig. 1, is made of thin pure sheet lead, which is corrugated horizontally and has trapezoidal holes punched in the depressions formed by corrugating. The punch that cuts these holes also cuts diagonally across the trapezoid, and instead of making a clean hole, fins are left which project on each side of the plate. The whole plate when punched resembles a corrugated grater, except that the fins are longer, and triangular in shape. These projections are then spread wider apart, so that a pressure on the plate will cause them to bend down in a direction away from the holes from which the fins project.

The material which is to become active is spread in the form of a powder on both sides of the grid, filling up the corrugations and being in sufficient quantity to make a flat plate of usual thickness after press welding. The whole is then subjected to a pressure of about 1000 lbs. per square inch of surface, which forms it into a solid mass. The material is bound to the grid by being pressed together into a continuous mass, which is on both sides of the grid and is welded through the multitude of small holes, thereby riveting itself in the grid. Additional hold is furnished by the fins, which bend down and are clinched over the active material.

The retention of the fins and riveting under pressure of the powder into a solid mass cannot be successfully accomplished with every form of material to become active, but it is stated that the material used in the Sperry battery welds up strongly in the press, and after the chemical formation becomes hard like soapstone. This active material consists of 80 to 85 per cent of finely divided pure lead, obtained by dissolving finely powdered lead in nitric acid and adding hydrochloric acid, producing a precipitation of lead chloride which is then dissolved and has added to it 15 to 20 per cent of lead oxide. These are thoroughly mixed, and to the mass thus formed is added about 1/25 of a compound of alkaline salts and other ingredients.

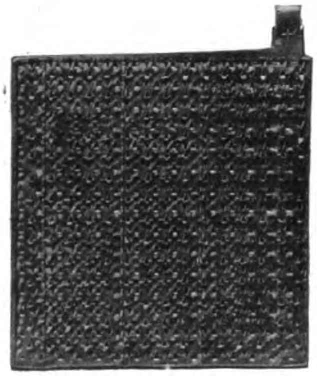


FIG. 1.—SPERRY BATTERY GRID.

The alkaline salts and the other ingredients are themselves inert, and their function is two-fold: First, to render the material porous by dissolving out when the plate is "formed," leaving numberless pores throughout the mass; and, second, they have the peculiar property of causing the mass to harden on forming instead of to soften, as is the case with pasted or other plates formed by the Planté process.

The composition of the active material used, its method of application and the formation in the Sperry battery, are such, however, that trouble from disintegration and dropping away of active material is obviated, and the maker claims, and its tests seem to indicate, that the plates are extremely hard, solid and durable. The corrugation of the grid horizontally allows proper expansion and relieves the plate of any tendency to buckle. As an additional precaution, however, Mr. Sperry has devised the pyroxylin coating which is applied to the outside of the plate and covers it, passing down one side, under the bottom of the plate and up the other side. It is evident that if any active material should be loosened by any extraordinary circumstances, it would not be able to drop off the plate, being held in position by the outside coating. If a particle of material should by any chance drop off, it will still be retained in the pyroxylin envelope and would not be able to short-circuit the battery.

This covering is made of open mesh cotton cloth, such as "cheesecloth," which is chemically treated, forming a cellulose nitrate which is termed "pyroxylin." This compound is of the same general character as gun cotton, which is a high explosive. The addition of a small quantity of nitro-benzol renders it inert. To the sheet of pyroxylin thus formed is applied a coating of pure cellulose. This is formed by treating fiber—in which the non-cellulose constituents belong to the class of aldehydes—with sulphurous acid. The fiber, after being washed, is again treated with sulphurous acid, leaving pure cellulose. This is then pulped and applied under pressure to the pyroxylin sheet. The envelope, when finished, is ribbed vertically, so that the electrolyte can circulate freely along the surface of the plate after passing through the envelope.

The jars in which the elements are placed are of the hard rubber variety, but different from the usual hard rubber jar in that they have a series of ribs capped with soft rubber extending across the bottom of the cell. On these soft resilient ribs rest the plates, which are in this way relieved from excessive shock or jar. The separators are the usual thin, perforated, ribbed, hard rubber. Fig. 2 shows a battery of 20 cells, complete. There are several sizes of these cells manufactured, the two principal ones being 2 ins. by 7¼ ins. by 10½ ins., and weighing 18 lbs. gross, and 3 ins. by 7¼ ins. by 10½ ins., and weighing 22.8 lbs.

A number of life tests have been made on this battery, both in laboratories and on vehicles and in practical work. One vehicle has now made about 7700 miles with the batteries, with a loss of 28 per cent of the original capacity.

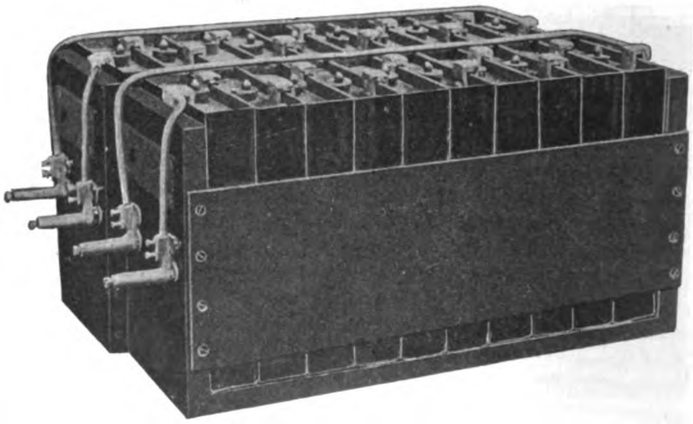


FIG. 2.—SPERRY BATTERY.

New Apparatus and Appliances

MIDGET PLUG AND RECEPTACLE.

Fig. 1, herewith, illustrates the Midget wall receptacle and plug, made by the Marshall-Sanders Company, of Boston. The receptacle has a porcelain shell and is provided with the usual polished metal face plate, with a lid to cover the slot when the plug is withdrawn. The plug is of porcelain, with two round contact pins fitting into corresponding holes in the terminal blocks within the plug. The socket is only one inch in diameter over all and one inch deep, and the plug projects only three-fourths of an inch from the wall.

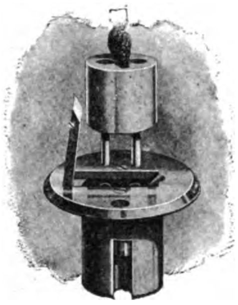


FIG. 1.—MIDGET PLUG AND RECEPTACLE.

KELLOGG TELEPHONE TRANSMITTER.

In the usual forms of solid-back transmitter the cell containing the granular carbon is fastened rigidly to the solid back. The front electrode being secured to the diaphragm, vibrates with it, and acts as a piston to vary the pressure on the granules, thus producing the transmission. The transmitter made by the Kellogg Switchboard & Supply Company, Chicago, and shown dismantled in Fig. 2, while differing from this construction, is said to possess all the advantages of the solid-back transmitter, together with several of its own. The cell containing the granular carbon is formed in, and constitutes a part of the diaphragm; and the piston electrode, corresponding to the front electrode in the solid-back transmitter, is rigidly held. This not only gives the piston effect, but also causes the carbon chamber to vibrate with the diaphragm, thus keeping the granules well shaken up. This is said to prevent packing, and to give a wide range of variation in resistance, resulting in powerful transmission. The electrodes are made from special carbon, with highly polished faces, and together with the granular carbon, are sealed in by riveting a retaining ring over a thin disc of mica. The diaphragm is formed from aluminum and surrounded by a soft-rubber gasket, held in tension by two steel springs. This construction is said to render the diaphragm highly sensitive to vibrations produced in close proximity to it, and at the same time prevent its taking up the noise of the room. The front of the transmitter, to which all of the parts are attached, is turned from solid brass, and the bridge to which the back electrode is fastened is also of brass. The mouthpiece is made from pure hard rubber, and is provided with a perforated partition to protect the diaphragm. All exterior parts of the transmitter are nickel-plated. The construction of the diaphragm, and the location of the electrode cell, cause all heat formed from excessive flow of current to be quickly radiated.

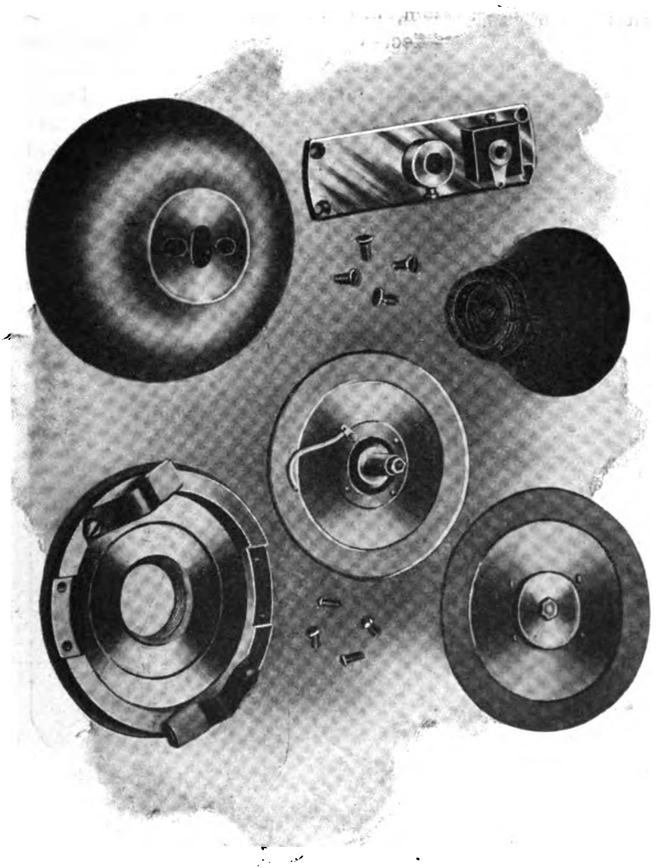


FIG. 2.—KELLOGG TELEPHONE TRANSMITTER.

NEW HOPPES FEED-WATER HEATER.

Fig. 3, herewith, shows a new form of feed-water heater made by the Hoppes Manufacturing Company, of Springfield, Ohio, and intended for installations where acidulated or other corrosive waters must be used. All of the parts coming in contact with the feed water are made of cast iron, and all bolts used are of bronze. In designing this heater, use was made of the well-known Hoppes method of causing water to flow along the underside of each pan in thin films, so that the exhaust must come in direct contact with the water. The pans are cast in one piece, joined at each end by a section, and provided at each corner with lugs for supporting them on the ways in the heater. The pan shown standing beside the heater in the engraving shows clearly the shape used in this construction. It will be noted that water can flow over the edge of the pans and also through the slots, the water flowing over the sides following the underside of the pan to the lowest point before dropping into the pan, and so on until it reaches the reservoir at the bottom. The comparatively flat form of this pan permits of about twice the amount of surface being put into a heater of a given size as compared with the original form. The heater is also provided with a hooded outlet for the pump suction, which acts as a skimmer, and when desired a filter is provided. A large oil catcher is located in the back of the heater, and a float and balanced valve are provided for regulating the feed-water inlet. As may be seen from the illustration, the entire head of the heater is removable to give easy access to all of its

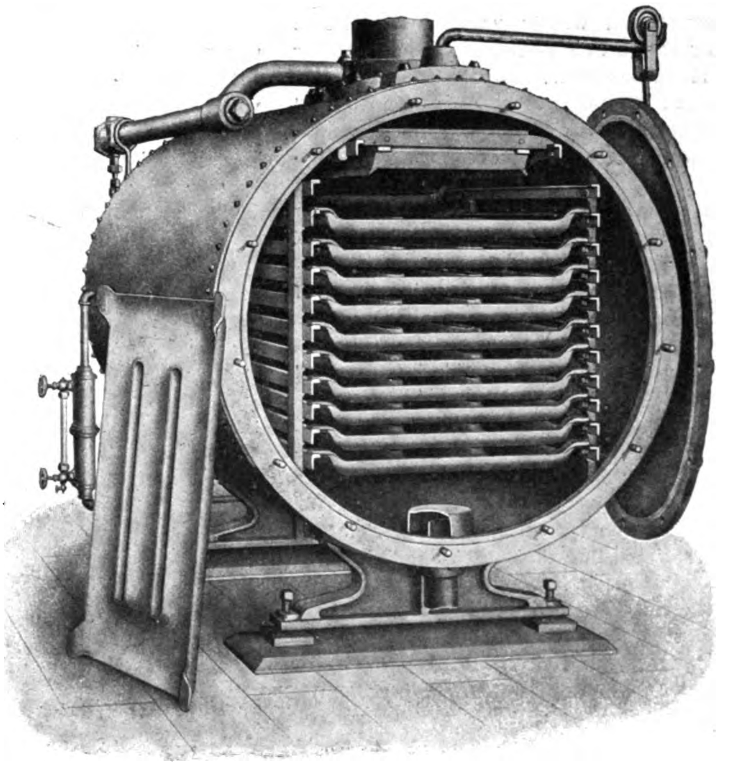


FIG. 3.—HOPPES FEED-WATER HEATER.

parts; a crane is provided for removing the head, as shown. A trap is provided for the oil drips from the overflow when the heater is installed in connection with a heating system; the large reservoir at the bottom adapts it for service as a heater and receiver when so installed.

NEW LINE OF ENCLOSED MOTORS.

The Holtzer-Cabot Electric Company, of Boston, has recently put on the market a line of enclosed motors designed for unusual and widely varying conditions. They range in size from 1/6 horse-power to 10 horse-power, and are adaptable for wall or ceiling suspension. Up to and including 3 horse-power the machines are bipolar, and above that they are multipolar. The field frame is of cast iron and is circular in shape, as shown by Fig. 4. The pole-pieces are laminated in order to reduce eddy-current losses, and the losses due to the heating effect of the current are kept well within limits by providing ample cross-section in all conductors. The poles fit into curved seats in the field ring, where they are held by bolts extending through the ring. The poles or cores and pole-pieces are integral, and the pole-tips are so shaped as to give the proper magnetic fringe for sparkless commutation. The armature laminations, like those of the field-magnet poles, are of annealed steel; the core is of the slotted type, and the coils are held in place and protected from injury by maple wedges running the entire length of the slots. The usual rocker arm, it will be noted, is absent, the brush-holder being mounted on a ring fitting snugly into a machined seat in the front-end case. This may be turned in either direction to set the brushes at the proper commutating point, being then clamped by two special screws. The terminals are placed conveniently on top of the machine, two special bosses being provided for that purpose. The connections are all made on the inside; but, if necessary, may be easily reached by slipping off the front-end case. The brush-holders of the larger sizes are of the standard radial type and are the same as those used on the Holtzer-Cabot multipolar open-frame machines. The brushes are clamped solidly to a machined surface on the holders, which are reinforced by a number of flexible copper strips, so that no springs or sliding contacts are depended on to carry current. On the smaller motors, which are likely to run a considerable length of time without attention, a box brush-holder is used with a parallel feed, which will allow a long period of wear. Motors built for buffing, grinding, polishing, or similar service, have a housing fitted over the commutator, completely enclosing the motor. Those built for service where minimum weight is imperative have all non-magnetic parts made of aluminum. The manufacturer claims unusually high efficiencies for units of this size, varying from 63 per cent in the smallest to 89 per cent in the larger sizes, with a relatively high efficiency on light loads.

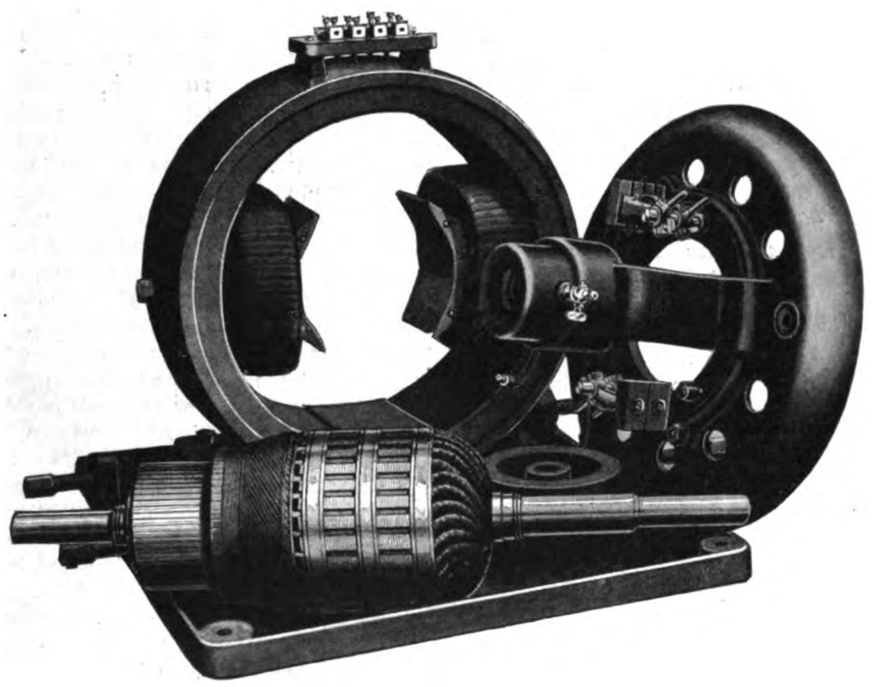


FIG. 4.—PARTS OF HOLTZER-CABOT ENCLOSED MOTOR.

"DIAMOND H" AUTOMATIC DOOR SWITCH.

The convenience of having lights in clothes closets and similar places which are entered only occasionally, and the economy of having such lights burning only when needed, has led to the use of door switches which are automatically operated as the closet door is opened and closed. The service under such conditions is more severe than in the case of switches operated by hand, as these are ordinarily used only a very limited number of times per day. The construction of the door switch must, therefore, be of the best. The switch must have a positive snap action, be particularly durable, and so designed as to reduce the labor of installation to a minimum. The "Diamond H" automatic door switch, built by the Hart Manufacturing Company, of Hartford, Conn., and illustrated herewith, was designed with these facts in view. It is enclosed in a steel case with semi-circular ends, this form of case facilitating letting the switch into the door jamb, as, after three 1-in. holes are bored, it is only necessary to cut out the wood between them to admit the case, without having to square up the ends of the oblong opening. The insulation of the current-carrying parts from the mechanism, as in all "Diamond H" switches, is effected by the use of sheet mica. The spring-bronze contacts are carried by a porcelain block, which is screwed to the bottom of the case and extends through the bottom at the end where the wires enter. The binding screws on the face of this block are accessible from the front.

The parts of the switch subjected to most wear are made of nickeled steel. The springs are of the best music wire, nickeled; they are helical in form and of large diameter. The action of the switch is said to be smooth and easy. The break

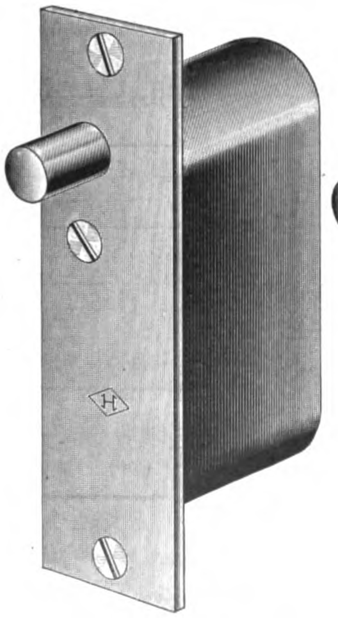


FIG. 5.—AUTOMATIC DOOR SWITCH.

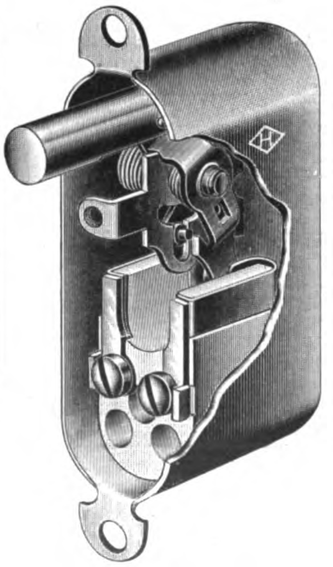


FIG. 6.—SWITCH "ON."

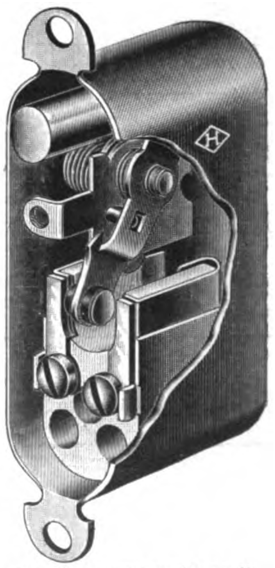


FIG. 7.—SWITCH "OFF."

is 1¼ ins. long, and is sufficient for 3 amperes at 250 volts. A steel template is furnished which, when placed against the door-jamb and tapped with a hammer, gives the location of the centers of the two screw holes at the ends of the face plate and also of the three 1-in. holes to be bored for the pocket. It also imprints the outline of the face plate. The manufacturer states that these switches have been given tests equivalent to several years of actual service, and that not one of the switches thus tested gave out or showed the slightest indication of weakness.

GILBERT'S SELF-PACKING WATER GAUGE GASKET.

Fig. 10, herewith presented, illustrates Gilbert's self-packing gasket for glass water gauges and its application to a gauge glass. The gasket is of rubber, and the form and method of using are plainly represented in the engraving. The features of the gasket are that it keeps the gauge glass out of contact with the metal of the fittings, allowing ample room for expansion, and it can be made perfectly tight without putting any strain on the glass and without the use of a wrench. These gaskets are made for all standard sizes of gauge glass by the Quaker City Rubber Company, Philadelphia, Pa.

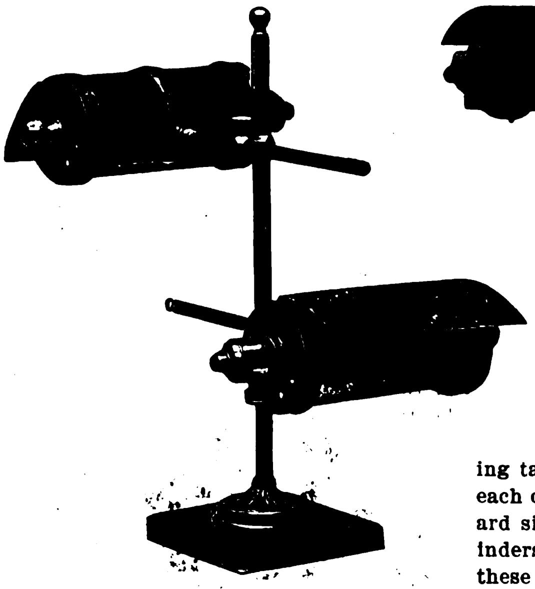


FIG. 8.—KINSMAN REFLECTORS.

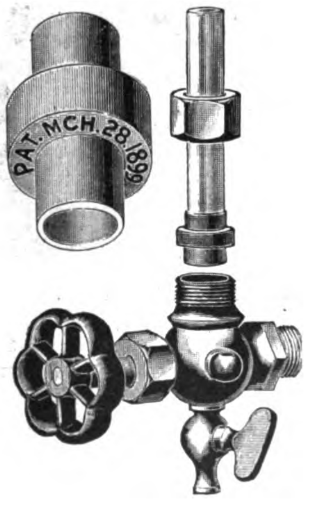


FIG. 10.—WATER-GAUGE GASKET.

NEW KINSMAN REFLECTORS.

The Kinsman cylindrical reflector for incandescent lamps is too well known to require more than mere mention in order to be recognized. Figs. 8 and 9, herewith, represent two special Kinsman reflectors which, however, may not be so universally familiar. Fig. 9 is a double cylinder portable, comprising a Kinsman cylinder reflector of double length, made to take two sockets and lamps—one at each end—and mounted on a portable standard. Fig. 8 is a double-head portable, designed for a double desk or a reading table at which two persons sit facing each other. Each cylinder is of the standard single-lamp type, but two double cylinders may be used, of course. Both of these fixtures are supplied by the makers, McLeod, Ward & Co., New York, in the usual finishes applied to the standard single type.

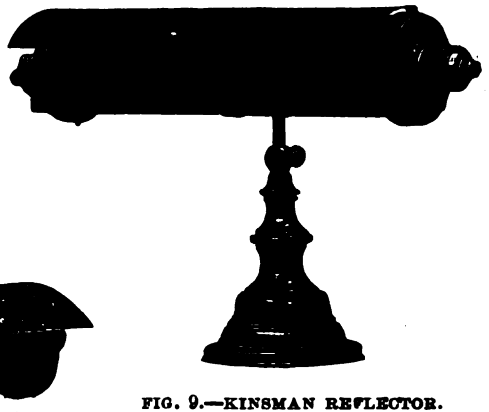


FIG. 9.—KINSMAN REFLECTOR.

NEW STANDARD FLASHLIGHT.

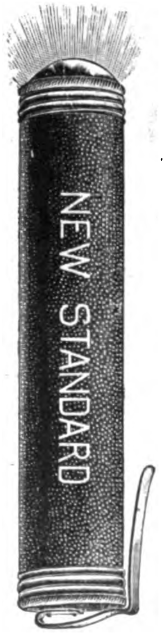


FIG. 11.—FLASHLIGHT.

Fig. 11, herewith, illustrates a battery lamp outfit known as the New Standard flashlight, which has been perfected and put on the market by William Roche, of New York. The appliance consists of a tube containing a small battery of special construction, a small incandescent lamp, and a bull's-eye lens. No connecting wires are used, the connections between the lamp and the battery being established by spring contacts within the case and the spring finger piece attached to the cap at the back end of the tube. The manufacturer states that the battery used is capable of giving 15 hours total service when used a few minutes at a time, and that it may be left standing for five or six months without deterioration. The tube is 9 ins. long and 1¾ ins. in diameter.

MANHOLE TRANSFORMERS.

In many large cities it has become necessary or expedient to place all electrical conductors underground. Where this practice is followed it is also necessary when transformers are used that these be placed in suitably arranged manholes. The Pittsburg Transformer Company, of Pittsburg, Pa., has developed a complete line of transformers for such service, one of which is represented by Fig. 12. These transformers are said to be absolutely water-tight, and to have a low temperature rise and high efficiency. The case is designed for the use of oil, and is of cast iron. The seam surfaces of the box and cover are machined, and a gasket placed between them; the lid is securely fastened by bolts. An expansion pipe leads from the case to a point above the high-water mark of the manhole, thus providing for changes of volume of the oil or air within the transformer. The company has adopted a design which gives low core and copper losses. The disturbing effect of inductive loads is minimized, it is stated, by a peculiar arrangement of the coils and a careful proportioning of the various parts. Lead-covered cables are brought out of the case through brass bushings tightly bolted to machined seats. A porcelain terminal block provides for 1000-volt or 2000-volt primary connection. The secondary leads pass up to a terminal block also, and may be connected in series or multiple, or for three-wire distribution. The company also furnishes manhole castings of various shapes.

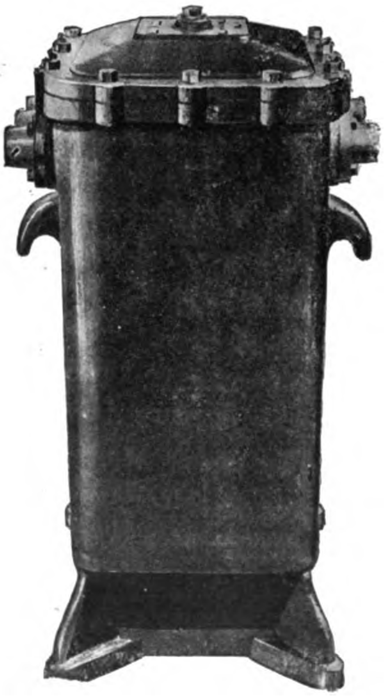


FIG. 12.—MANHOLE TRANSFORMER.

Some of the Exhibits at the Street Railway Convention.

The exhibit feature of the convention of the American Street Railway Association, held last month at Madison Square Garden, appears to have been one of the most successful that has ever been known in conjunction with the meetings of this association. There was a large quantity of apparatus displayed, most of which reflected positive advances in the art, there being very few actual "repeaters" from previous exhibitions. Among those exhibitors coming properly within the scope of this paper were the following:

FIG. 1.—A VIEW INCLUDING THE GENERAL ELECTRIC EXHIBIT.

THE GENERAL ELECTRIC COMPANY occupied a commodious space near the main entrance of the Garden. The exhibit included a Type M railway motor controller, which is the type that has been contracted for by the Manhattan Elevated Company. This controller was shown in actual operation with incandescent lamps substituted for the motors, the rise and fall of light intensity indicating the rise and fall of speed in the motors. There was also exhibited an electrically-operated oil circuit-breaker for 11,000 volts, which was shown in practical operation, and which is the type of switch that will be used by the Manhattan Elevated Company. Among other exhibits representing apparatus that will be used in the equipment of the Manhattan Elevated were two 125-h.p. motors and direct-current and alternating-current switchboard panels fully equipped. The whole exhibit covered about 250 sq. ft.

SPRAGUE ELECTRIC COMPANY, New York, showed an interesting arrangement of multiple-unit control apparatus, comprising complete equipment for two motor cars and intermediate non-tractive cars with means for connecting-up in various relations. The controllers were of the type recently introduced on the Boston Elevated system. The car equipments consisted of four Lorain steel motors for one car and four motors loaned by the Brooklyn Heights Railway Company for the other, the latter equipment being mounted on Peckham trucks. The multiple-unit system was thoroughly demonstrated and attracted a great deal of well-deserved attention. The company was represented by Frank J. Sprague, Francis H. Shepard, Geo. H. Hill, Henry G. Issertel, Alexander Henderson, S. H. Libbey, and H. M. Davis.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, of Cincinnati, and the **WAGNER ELECTRIC MANUFACTURING COMPANY**, of St. Louis, sent the manager of their sales department, Mr. F. G. Bolles, to the convention to look after the companies' interests. Many of the delegates were pleased recipients of the handsome souvenirs which Mr. Bolles distributed in the shape of "gold medals," and pencils bearing his companies' imprint.

THE WESTINGHOUSE COMPANIES also had extremely interesting exhibits, the principal feature of which was a car equipped with the Newell combined track and wheel brake, which has been described previously in our columns. The car was operated on a stretch of track 100 ft. long, built with a grade of about five per cent. The efficacy of the brake was amply demonstrated by running the car almost at full speed from the upper end of the incline to within a few feet of the lower extremity and then throwing on the brake. Other demonstrations consisted of quick stops immediately after starting, and reduction of speed while coasting, etc. This track is shown in the center of Fig. 2. Besides this exhibit there were six railway motors unmounted and three motors mounted on trucks, the motors being of various styles; a Baldwin-Westinghouse mine locomotive complete; a Westinghouse railway switchboard through which current was supplied to the operative exhibit above mentioned; and a large number of specialties. The switchboard represented the latest standard railway practice, the panels being of blue Vermont marble and containing the most recent types of switchboard instruments and switches. There were also exhibited a canopy of several strings of Nernst lamps in operation, together with a color case of silks to demonstrate the efficacy of the light in giving true

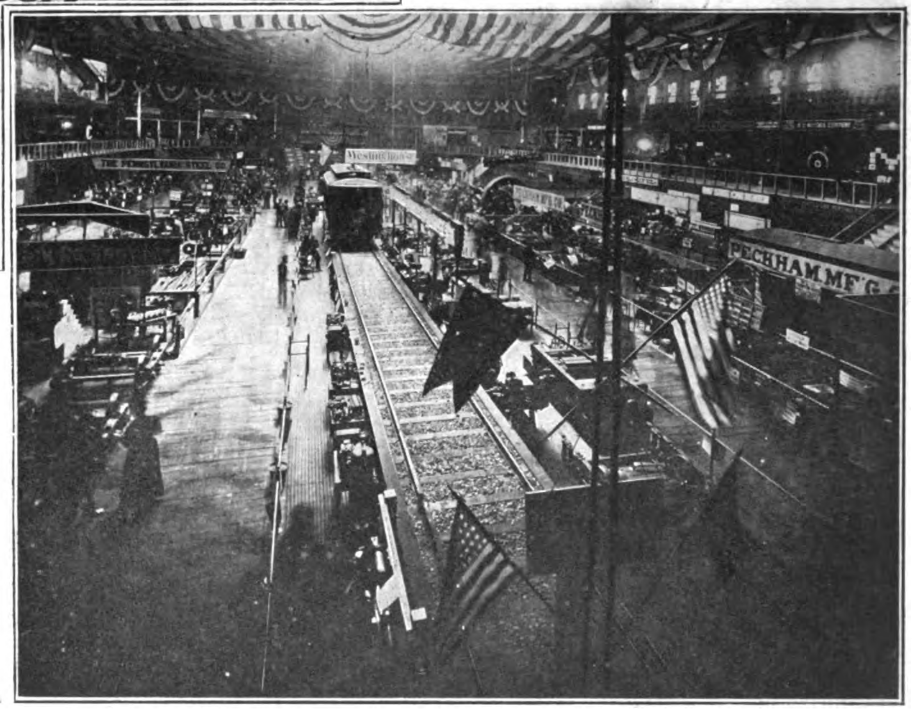


FIG. 2.—A VIEW INCLUDING THE WESTINGHOUSE COMPANIES' EXHIBIT.

color values. The companies were ably represented by Messrs. B. H. Warren, F. H. Taylor, Arthur Warren, N. W. Stone, L. A. Osborn, A. M. Mattice, and many others, representing the Westinghouse Electric & Manufacturing Company; A. J. Wurts, H. N. Potter and Dr. Recklinhausen, of the Nernst Lamp Company; C. J. Jennings, W. F. Martins and G. D. Prentiss, of the Sawyer-Man Electric Company; and H. H. Westinghouse, John F. Miller, E. M. Herr, Joseph R. Ellicott, Andrew J. Brislin, John J. McCutchan, and others, of the Standard Traction Brake Company, which is the consolidation of the Westinghouse and Standard Air Brake Companies.

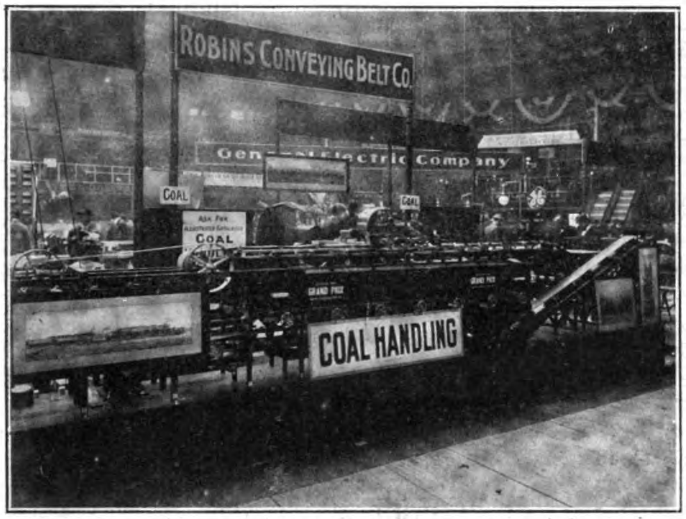


FIG. 3.—EXHIBIT OF THE ROBINS CONVEYING BELT CO.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., enjoyed the distinction of being the only manufacturer who had on exhibition a railway generator. This company's space contained two splendid-looking generators, one of 200 kilowatts and one of 400 kilowatts capacity, and both built for direct connection. The company's representatives made many new friends among the delegates present and lost no opportunity to point out the merits of Crocker-Wheeler apparatus, although not much effort in this direction was necessary in view of the excellent specimens shown. The exhibit was in charge of Mr. F. B. De Gress, manager of the New York office, who was assisted by Messrs. L. P. Hammond and H. C. Mortimer, Jr. There were also present during the convention, Dr. S. S. Wheeler, president of the company; Prof. F. B. Crocker, vice-president; Messrs. A. L. Doremus, secretary; P. L. Bates, assistant secretary; W. L. Brownell, treasurer; G. W. Bower, assistant treasurer; G. S. Dunn, chief engineer; F. V. Henshaw, assistant engineer; H. L. Patterson, purchasing agent; A. Hartmann, superintendent; S. Russell, Jr., J. H. Craig, L. P. Hall, Julian Roe and W. H. Wissing, managers of various branch offices.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, of Warren, Ohio, lighted the annex with its spiral filament incandescent lamps. These lamps were also shown in the space of Francis Granger, the company's New York representative. Wm. Coale was present in the interests of the company.

THE H. B. CAMP COMPANY, of Akron, Ohio, displayed samples of its vitrified conduit duct. The exhibit was in charge of C. C. Baird, of the New York office, who pointed out to many of the delegates the large amount of conduit work being done by his company in New York and vicinity.

THE ROBINS CONVEYING BELT COMPANY, New York, exhibited two extremely interesting model belt conveyors built on the scale of 3 ins. to the foot and equipped with automatic self-reversing trippers. The conveyors were in continuous operation during all three days of the convention, elevating and distributing material precisely as a full-size conveyor would do, performing this work with almost absolute noiselessness. These conveyors are extensively used in boiler and power houses for handling coal and ashes, and are constantly gaining in favor as their intrinsic merits become more generally known.

THE CRANE COMPANY, of Chicago, exhibited a large selection of its valves and pipe fittings. Details of construction of both gate and globe valves were shown by partially cutting away sections of the metal. The exhibit included a 24-inch gate valve, and several examples of extra-heavy brass globe valves and gate valves, together with a valve intended for 800 lbs. per square inch working pressure. P. A. Kimburg was in charge of the exhibit.

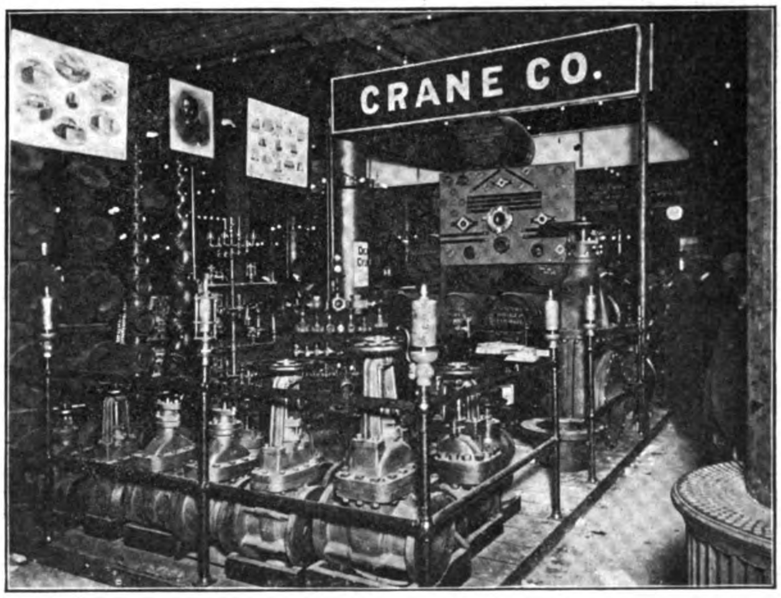


FIG. 4.—THE CRANE CO.'S EXHIBIT.

ROSSITER, MAC GOVERN & CO., of New York, well-known dealers in electrical and steam apparatus, were represented by Frank MacGovern.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, of Pittsfield, Mass., which has recently entered the railway field, was represented by S. T. Dodd, manager of the railway department, C. E. Bibber and Messrs. Kelly and Jackson.

THE NATIONAL CARBON COMPANY, of Cleveland, showed a full line of carbon brushes of all sizes, and for all kinds of electric motors, etc. R. K. Mickey, of Cleveland, A. E. Carrier, of New York, and Secretary H. J. Davies, looked after the company's interests.

THE GARTON-DANIELS COMPANY, of Keokuk, Ia., was represented by General Manager J. V. E. Titus, who had on exhibition the new "Automotoneer," which this company has recently perfected. This is a new device which the company has heretofore hesitated to put on the market because it was not satisfied that the design was the simplest and most practical one that could be used, but it is now ready to equip controllers with this apparatus, in the belief that it will be thoroughly satisfactory. In addition to being effective, the device is exceedingly simple in its construction, consisting, as it does, of two gear wheels, a plunger and a wheel with four pins in its periphery. For the information of those who are not familiar with the device it may be said that its object is the limitation of the rate at which current is turned on in accelerating a car.

THE McROY CLAY WORKS, of New York and Chicago, was represented by E. F. Kirkpatrick, of Chicago, who is as much at home at street railway as at electric light conventions. The company has practically sold its entire output for the coming year, and has found it necessary to increase its facilities by the installation of electrical machinery to operate its entire plant, which will enable it to do not only twice the amount of work, but also to materially lessen the cost of production.

THE WESTERN ELECTRICAL SUPPLY COMPANY, of St. Louis, sent Charles Scudder, Jr., manager of its railway department, to the convention.

THE JOHN A. ROEBLING'S SONS COMPANY was represented by H. L. Shippy, manager of the New York office, and by Messrs. Bailey, Harrington and Cockey.

THE OKONITE COMPANY, of New York, was represented by Messrs. W. L. Candee, G. T. Manson and H. Durant Cheever.

HUGO REISINGER, of New York, importer of "Electra" carbons for electric lighting purposes, was represented at the convention by A. T. Webb.

MACHADO & ROLLER, of New York, had an exhibit with Harold P. Brown, where they showed the new Whitney railbond testing instrument which has met with such a gratifying demand among street railway companies.

THE SPEER CARBON COMPANY, of St. Mary's, Pa., was represented at the convention by J. S. Speer, general manager, who had with him a full line of his company's well-known carbon brushes and other specialties.

THE ACME SWITCH COMPANY, of Hartford, Conn., through its president, George L. R. Eldridge, interested many of the delegates in the new time switch which this company is now putting on the market.

THE SIMPLEX ELECTRICAL COMPANY, of Cambridgeport, Mass., exhibited a line of electric car heaters and other electric heating devices for various purposes. The company was represented by Roger Williams and J. H. Mason.

THE CUTTER COMPANY, of Philadelphia, the well-known manufacturers of "I-T-E" circuit-breakers, was represented at the convention by G. N. Annable. A. E. Newton, president of the company, came over from Philadelphia, to attend the convention.

THE PHOENIX GLASS COMPANY, of New York and Pittsburg, manufacturers of globes, shades and other electrical glassware, was represented at the convention by vice-president and general manager A. H. Patterson, and general sales agent E. H. Peck.

THE AMERICAN VITRIFIED CONDUIT COMPANY, New York, had an excellent display of single and multiple duct conduit. The company also exhibited its third-rail insulator, 50,000 of which will be used on the Manhattan Elevated road.

THE KEYSTONE ELECTRICAL INSTRUMENT COMPANY, of Philadelphia, had its exhibit in the space of its New York agent, the Morris Electric Company. President J. F. Stevens was present, and showed many interested delegates his switchboard and portable instruments in various types and ranges.

THE VAN DORN-ELLIOTT ELECTRIC COMPANY, of Cleveland, showed a full line of its commutators, armature and field coils, and a sample of its work in rewinding armatures. The company makes a specialty of repair work in electric railway companies. The company was represented by W. H. Elliott and W. A. Dutton.

THE DEARBORN DRUG & CHEMICAL COMPANY, of Chicago, had its booth filled with samples of its product. This company makes a specialty of analyzing waters and eradicating scale in boilers. Some interesting examples of scale formation were shown. The company's interests were looked after by R. F. Carr, vice-president and general manager, and W. B. McVicker, New York manager.

THE CLING-SURFACE MANUFACTURING COMPANY, of Buffalo, N. Y., through its Eastern agent, C. F. Chase, distributed an attractive circular illustrating belts treated with Cling-Surface. Mr. Chase had space in the balcony, where he explained to many interested delegates the advantages of a belt running slack when treated with Cling-Surface, as compared with the old method of running tight belts.

THE STERLING VARNISH COMPANY and the PITTSBURG INSULATING COMPANY, of Pittsburg, showed samples of their new insulating fabrics. They guarantee insulation of from 8000 to 15,000 volts puncture test. The exhibit was in charge of H. L. Brass, S. C. Schenck, and several sales agents. The companies distributed sample books containing specimens of the various grades of their specialties.

THE GOULD STORAGE BATTERY COMPANY, New York, showed samples of its plates used in storage battery work. The exhibit also included a cell with an antimony-lead tank for central station use, fitted with glass plates inside for insulating purposes. The company also showed two of its 600-ampere-hour cells. The exhibit was in charge of W. S. Gould, general manager, W. W. Donaldson, sales engineer, and A. S. Hubbard, consulting engineer.

THE STANDARD UNDERGROUND CABLE COMPANY, of Pittsburg, while it did not show any samples of its well-known wires and cables at the Garden, had a number of its representatives present, including C. J. Marsh, manager of the Eastern and Northeastern division; T. E. Hughes, manager of the Southeastern sales department; A. B. Saurman, manager of the Northeastern sales department; and G. L. Wiley, manager of the Eastern sales department.

THE LE VALLEY VITAE CARBON BRUSH COMPANY, of New York, exhibited a number of carbon brushes which had been used by various street railway companies, and above which was placed a statement of the number of miles the carbon had been used, and the wear it showed at the end of that time. The results were exceptionally favorable, and substantiated the company's claim for the life of its brushes. This company also exhibited a complete line of generator and motor brushes of various sizes and shapes.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, had its interests ably looked after by Messrs. Blizard and Reynolds, of Philadelphia, and Taylor and Kundsen, of New York. The company's exhibit included a railway battery switchboard panel with a differentially wound motor-driven booster, and samples of typical railway cells. An interesting feature of the exhibit was a map of the city showing locations of "Chloride Accumulator" installations by means of colored "bull's eyes." Col. G. H. Day, president of the company, was also present.

THE NEW PROCESS RAWHIDE COMPANY, of Syracuse, N. Y., was ably represented by Secretary A. C. Vosburg and T. G. Meachem, who distributed a souvenir rawhide-covered match case and cigar cutter. The company had on exhibition a case of sample rawhide pinions, complete gears and blanks. Many visitors were interested in a pinion which had been run 105 miles a day for fourteen months. The teeth were worn to a knife edge without giving way. Above the company's exhibit was a sign made of the grade of rawhide used in pinions, and the difficulty experienced in putting holes in the sign to fasten it up was one of the best recommendations for the quality of the material.

THE AMERICAN CIRCULAR LOOM COMPANY had a full staff of representatives present, including H. B. Kirkland, general sales manager; J. L. Kirkland, of the New York office; Thos. G. Grier, of Chicago; and R. B. Corey, of New York. The company is entering extensively into the street railway field, and the managers of leading street railways are realizing the merits of American circular loom and the fact that it can be applied to a great many purposes in street railway operation. The company's representatives distributed a handsome souvenir in the shape of a smoker's outfit. It should be stated that all the circular loom required in the electrical installations at the Garden was supplied by this company.

THE H. W. JOHNS MANUFACTURING COMPANY, of New York, had a working exhibit which demonstrated the relative merits of the Sachs Noark fuses and the ordinary open fuse, both on short-circuit and heavy overloads. Two fuse boxes, one for open fuses and one for enclosed Noark fuses, were erected, and by passing current through the two types the difference was made clearly evident. Three large elevated lines, and over 6,000 surface cars have been equipped with Noark fuses, and the company showed at the Convention two examples of fuse boxes particularly designed for elevated and surface lines. The exhibit was in charge of A. Hall Berry, manager of the electrical department of the New York office; Joseph Sachs, and numerous other representatives.

THE STANDARD PAINT COMPANY, New York, had a most interesting and attractive exhibit. The furnishing of the P & B booth, which was located on the northern promenade, near the Madison Avenue entrance, was of quartered oak, and the full line of P & B manufactures was attractively displayed. In addition to P & B electrical compounds, the company displayed other goods, such as armature and field coil varnish, insulating tape, waterproof insulating papers, ruberoid motor cloth, preservative paints for poles, hoods, etc., and ruberoid floorcloth and roofing. The paints mentioned are extensively used as a preventive of electrolysis. Prominent among the company's representatives were Ralph L. Shainwald, president, J. C. Shainwald, J. N. Richards, F. F. Vande Water, and Charles Earnshaw.

◆

NEW BOOKS.

Electricity Made Simple. By Clark Caryl Haskins. Chicago: Published by the Author. Paper or cloth; 233 pages, 5 × 7 ins.; 108 illustrations. Price, paper, 50 cts., cloth, $1.00.

This little book treats of electricity and magnetism in a very simple and wholly non-mathematical manner. The principles of static and voltaic electricity, electromagnetism and electrolysis are explained in elementary terms, and some of the principal industrial applications of electricity are briefly indicated.

Electrical Designs. New York: American Electrician Company. Cloth; 403 pages, 6 × 9½ ins.; 325 illustrations. Prices, $2.00.

This is a collection of designs for electrical apparatus of various kinds, ranging from a telephone receiver to a 4-kw. double-current generator. The list includes direct-current motors of 1/6 to 3 horse-power capacity; double-current generators (or rotary converters) of 1 to 4 kilowatts capacity; a single-phase rectifier; a small alternator; several voltmeters, ammeters and wattmeters; different forms of galvanometer; testing sets; a storage battery; an arc lamp; induction coils; static machines; telephones, and a photometer. In each case complete instructions are given for the construction of the apparatus, accompanied by dimensioned drawings. The designs are all within the ability of a fairly skilful amateur mechanic.

Electromagnets; Their Design and Construction. By A. N. Mansfield. New York: D. Van Nostrand Company; 1901. Linen on boards; 155 pages, 3¾ x 6 ins.; 36 illustrations. Price, 60 cents.

This is No. 64 of the Van Nostrand "Science Series," and supersedes Du Moncel's old effort on the same subject. The author has carried out his aim as well as might be expected in view of space limitations. The first chapter is devoted to a very short historical sketch, an explanation of magnetic properties, and a summary of the different forms of magnet that are industrially used. (Incidentally, the horseshoe form depicted by Fig. 4 is inaccurately referred to as one "very extensively used," whereas it is very rarely used—probably in less than one per cent of even the small electromagnetic mechanisms.) The second chapter is an exposition of the principles of magnetism and the behavior of magnetic materials. The remainder of the book deals with the design and construction of electromagnets for various kinds of work and classes of exciting current. The author's style is remarkably clear, but he has unfortunately departed from established usage in his nomenclature, so that anyone who is accustomed to associate the letter X with reactance and F with magnetomotive force, for example, will find it a little confusing to translate X as reluctance (usually indicated by French script R) and F as magnetic flux (almost invariably indicated by Φ)

Awards at the Pan-American Exposition.

The Juries of Award at the Pan-American Exposition, Buffalo, have completed their labors, and while the official list of awards has not been made public an unofficial list has been given out, from which we have selected the subjoined list giving the awards which are of most interest to our readers. It may be interesting to note that the total number of exhibits examined by the various juries aggregated 7000, and that 150 persons served upon the juries under the general direction of Dr. Henry S. Pritchard, superintendent of awards. The detail work of the various juries was passed upon by a superior jury of about 40 members, who determined finally and without appeal the order of merit of the awards. It is to be regretted that several of the largest and best-known manufacturers in the country did not compete for awards, requesting that in considering this question their exhibits should be ignored; this fact should be borne in mind by readers finding the names of prominent companies "conspicuous by their absence" from the list. The awards relating to electrical and steam engineering and allied industries were as follows:

DIVISION VIII.—MINES AND METALLURGY.

Jurors.

John Birkenbine, chairman; Juan D. Fleury, J. A. Holmes, Jefferson Middleton, Heinrich Ries and Guillermo Yunge.

Gold Medals.—American Steel & Wire Company, steel and finished steel products.

Edward G. Acheson, Niagara Falls, N. Y., artificial graphite and carborundum.

Calumet & Hecla Mining Company, Buffalo, N. Y., cast copper.

Lidgerwood Manufacturing Company, New York, hoisting and mining engines.

Norton Emery Wheel Company, Worcester, Mass., corundum wheels.

Niagara Falls Power Company, Niagara Falls, products made with electric current.

Silver Medals.—Baker & Co., Newark, N. J., platinum products.

H. W. Johns Manufacturing Company, New York, exhibit showing evolution of asbestos.

Mine & Smelter Supply Company, Denver, Colo., electric rock drill.

Bronze Medals.—Granby Mining & Smelting Company, Oronogo, Mo., zinc concentrates.

McKenna Brothers, Pittsburg, Pa., laboratory ore grinder.

New York State Museum, Albany, N. Y., slate.

Rich Hill Zinc Works, Rich Hill, Mo., zinc products.

St. Joseph Lead Company, Bonne Terre, Mo., lead and lead ores.

Sills-Eddy Mica Company, New York, samples of mica mined in the United States.

Royal Blue Mines, Joplin, Mo., zinc and lead ores.

Union Mining Company, Mt. Savage, Md., fire brick.

Honorable Mention.—Metallic Lubricating Oil Company, Millersburg, Pa., machine oil.

Peach Bottom Slate Company, Delta, Pa., slate.

DIVISION IX.—MACHINERY.

Jurors.

Ira N. Hollis, chairman; Luis de Arozarena, Wm. L. Aughinbaugh, Prof. R. C. Carpenter, Mortimer E. Cooley, E. G. Fischer, Chas. T. Higginbotham, Emique Lanz, Prof. C. H. Peabody, Perry Benjamin Pierce, H. W. Spangler and Frederick A. Tennant.

Gold Medals.—J. L. Alberger & Son, Buffalo, N. Y., tandem gas engine.

American Steam Gauge & Valve Company, Boston, Mass., steam gauges and engine fittings.

American Steel & Wire Company, Chicago, dies for drawing wire.

Buffalo (N. Y.) Forge Company, steam engines and blowers.

The Carborundum Company, Niagara Falls, carborundum.

Cleveland (Ohio) Twist Drill Company, drills, reamers and cutters.

Forster Pulley Works, Fairport, N. Y., split wood pulleys.

Ferracute Machine Company, Bridgeton, N. J., stamping machinery.

Jenkins Brothers, New York, valves and packing.

The Lunkenheimer Company, Cincinnati, Ohio, valves and engine fittings.

Lazier Gas Engine Company, Buffalo, N. Y., gas engines.

Marinette (Wis.) Iron Works Manufacturing Company, gas engines.

August Mietz, New York, kerosene oil engines.

Morse Twist Drill & Machine Company, New Bedford, Mass., machine tools.

National Meter Company, New York, gas engines.

Otto Gas Engine Works, Philadelphia, Pa., gas engines.

Robins Conveying Belt Company, New York, belt conveyor.

Rodney Hunt Machine Company, Orange, Mass., water wheels and pumps.

Reeves Pulley Company, Columbus, Ind., variable speed transmission.

John A. Roebling's Sons Company, Trenton, N. J., wire and wire rope.

Rider-Ericsson Engine Company, New York, hot air engine.

The Straight Line Engine Company, Syracuse, N. Y., steam engines.

Chas. A. Schieren & Co., New York, leather belting.

Struthers, Wells & Co., Warren, Pa., gas engines.

The O. C. White Company, Worcester, Mass., appliances for shop lighting.

Western Tube Company, Kewanee, Ill., valves and cocks.

Henry R. Worthington, New York, jet condenser.

Walworth Manufacturing Company, Boston, Mass., valves, fittings and tools.

Silver Medals.—American Steel & Wire Company, cold drawn shafting.

American Blower Company, Detroit, Mich., fans and blowers.

Ames Iron Works, Oswego, N. Y., steam engines.

American Pulley Company, Philadelphia, Pa., pulleys.

Ball Engine Company, Erie Pa., steam engines.

Bessemer Gas Engine Company, Globe City, Pa., two-cycle gas engine.

Buffalo (N. Y.) Gasoline Motor Works, gasoline engine.

Burt Manufacturing Company, Akron, Ohio, Cross oil filters.

E. W. Bliss Company, Brooklyn, N. Y., sheet metal stamping and drawing machines.

Belmer-Eames Tool Company, Cincinnati, Ohio, planers.

A. S. Cameron Pump Works, New York, steam and air pumps.

Dodge Manufacturing Company, Mishawaka, Ind., iron and wood split pulleys.

The Deane Steam Pump Company, Holyoke, Mass., condensers and pumps.

Eddy Valve Company, Waterford, N. Y., gate valves.

Fulton (N. Y.) Pulley Company, wood pulleys.

Fitchburg (Mass.) Steam Engine Company, engine.

The Foos Manufacturing Company, Springfield, Ohio., gas and gasoline engines.

The Fairbanks Company, Buffalo, N. Y., steam valves.

The Green Fuel Economizer Company, Matteawan, N. Y., fuel economizer.

Jenkins Brothers, New York, pump valves and disc.

Kieley & Mueller, New York, steam specialties.

The Lane & Bodley Company, Cincinnati, Ohio, Corliss engines.

New York Leather Belting Company, Victor leather belting.

The Wm. Powell Company, Cincinnati, Ohio, oil cups and valves.

Reeves Pulley Company, Columbus, Ind., split wood pulleys.

Taber Pump Company, Buffalo, N. Y., rotary pumps.

J. H. Williams Company, Brooklyn, N. Y., drop-forged wrenches.

Wheeler Condenser & Engineering Company, New York, Admiralty surface condenser with combined air and circulating pump.

Weber Gas & Gasoline Engine Company, Kansas City, Mo., gas and gasoline engines.

Bronze Medals.—Abendroth & Root Manufacturing Company, New York, water-tube boilers.

American Blower Company, Detroit, Mich., blower engine.

The American Pulley Company, Philadelphia, Pa., split wrought-steel pulley.

Atlas Pipe Wrench Company, New York and San Francisco, pipe wrenches and boiler tube cleaners.

Cyclone Grate Bar Company, Buffalo, N. Y., grate bars.

Chicago (Ill.) Belting Company, Reliance leather belting.

Dodge Manufacturing Company, Mishawaka, Ind., friction clutches.

The Garlock Packing Company, Palmyra, N. Y., packing.

Harrison Safety Boiler Works, Philadelphia, Pa., Cochrane steam and oil separator, and drainage system for vacuum oil separator.

Jacobson Machine Manufacturing Company, Warren, Pa., clutch pulley.

Robert A. Keasbey, Buffalo, N. Y., magnesia covering.

Knowles Steam Pump Works, New York, triplex electric pump.

Murray Iron Works, Burlington, Iowa, Corliss engines.

Nemes Brothers, Troy, N. Y., shaking grate.

The National Pipe Bending Company, New Haven, Conn., coils of iron, brass and copper pipe.

Oneida (N. Y.) Steel Pulley Company, steel pulleys.

The Replogle Governor Works, Akron, Ohio, water-wheel governors.

Sherwood Manufacturing Company, Buffalo, N. Y., injectors and boiler-tube cleaners.

Skinner Engine Company, Erie, Pa., engines.

The Snow Steam Pump Works, Buffalo, N. Y., pumps.

Underfeed Stoker Company of America, Chicago, Jones mechanical stoker.

Watertown Engine Company, Watertown, N. Y., Corliss engines.

Honorable Mention. — American District Steam Company, Lockport, N. Y., underground system of heating.

Cling-Surface Manufacturing Company, Buffalo, N. Y., belt dressing.

Dodge Manufacturing Company, Mishawaka, Ind., iron-hub wood-rim pulleys.

Harrison Safety Boiler Works, Philadelphia, Pa., Cochrane feed water heater and purifier.

The Kennedy Valve Company, New York, iron and brass valves.

South Bend (Ind.) Pulley Company, split wood pulleys with iron hubs.

Vincent Valve Company, Sandusky, Ohio, globe and gate valves.

DIVISION X.—ELECTRICITY.

Jurors.

Carl Hering, chairman; Arthur Vaughn Abbott, Prof. H. S. Carhart, Prof. W. S. Franklin, Prof. W. E. Goldsborough, Prof. Dugald C. Jackson, Dr. A. E. Kennelly and Prof. Wm. L. Puffer.

Gold Medals.—American Steel & Wire Company, Chicago, wires and cables.

Belding Brothers, New York, electrical silk.

P. B. Delany, South Orange, N. J., rapid telegraph apparatus.

General Electric Company, generating and translating apparatus, lighting apparatus and measuring instruments.

Holophane Glass Company, New York, glass globes.

Eldridge R. Johnson, Camden, N. J., mechanical apparatus for reproducing sound.

Kellogg Switchboard & Supply Company, Chicago, telephone apparatus.

National Carbon Company, Cleveland, Ohio, carbon products.

Niagara Falls (N. Y.) Power Company, transmission plant illustrated by model.

Pittsburgh Reduction Company, Pittsburg, Pa., aluminum conductors.

John A. Roebling's Sons Company, Trenton, N. J., wires and cables.

The Safety Insulated Wire & Cable Company, New York, wires and cables.

Standard Underground Cable Company, Pittsburg, Pa., wires and cables.

Stanley Electric Manufacturing Company, Pittsfield, Mass., alternating-current apparatus.

Stanley Instrument Company, Great Barrington, Mass., wattmeters.

Stromberg-Carlson Telephone Manufacturing Company, Chicago, telephone exhibit and service.

Silver Medals.—The American Clock Company, Chicago, electric clocks.

American Vitrified Conduit Company, New York, vitrified clay conduits.

The E. G. Bernard Company, Troy, N. Y., motor-generator sets and accessories.

Bullock Electric Manufacturing Company, Cincinnati, Ohio, dynamos and motors.

H. B. Camp Company, Akron Ohio, vitrified conduits.

Crocker-Wheeler Company, Ampere, N. J., dynamos and motors.

Cutler-Hammer Manufacturing Company, Milwaukee, Wis., motor starters and controllers.

D. & W. Fuse Company, Providence, R. I., fuses and fuse fittings.

Edison Manufacturing Company, Orange, N. J., phonographs and Edison-Lalande battery.

Electric Storage Battery Company, Philadelphia, Pa., storage batteries and methods and appliances for the distribution of electric energy.

Eureka Tempered Copper Works, North East, Pa., tempered and cast copper.

Gould Storage Battery Company, New York, storage battery.

Hazard Manufacturing Company, Wilkesbarre, Pa., insulated wire and cables.

Hydra Double Battery Co., New York, dry battery.

Illuminating Appliance Co., New York, prismatic reflectors.

McRoy Clay Works, Brazil, Ind., vitrified conduits.

National Gramophone Corporation, New York, gramophones.

Northern Electrical Manufacturing Company, Madison, Wis., direct-current dynamos and motors.

Queen & Co., Philadelphia, self-regulating X-ray tube.

Stanley Electric Manufacturing Company, Pittsfield, Mass., measuring instruments.

R. V. Wagner Electric Manufacturing Company, Chicago, mica plate Holtz machine.

Wagner Electric Manufacturing Company, St. Louis, single-phase motors and transformers.

Bronze Medals.—American Electric Telephone Company, Chicago, telephone apparatus.

American Engine Company, Bound Brook, N. J., direct-current dynamos.

Lieut. G. Bettini, New York, phonographic apparatus.

Bossert Electric Construction Company, Utica, N. Y., switches.

Harold P. Brown, New York, plastic amalgam joints.

Clark Automatic Telephone & Switchboard Company, Providence, R. I., automatic telephone switchboard.

The Dicke Tool Company, Downers Grove, Ill., electric wiremen's tools.

Incand. Elec. Light Manipulator Company, Boston, Mass., lamp manipulator and attachments.

The Jandus Electric Company, Cleveland, Ohio, enclosed arc lamp.

Jantz & Leist, Cincinnati, Ohio, electroplating dynamos and driving motor.

Keystone Electric Company, Erie, Pa., direct-current generator.

P. M. Lincoln, Niagara Falls, N. Y., phase indicator.

Mason Monogram Company, New York, illuminated sign.

Morris Electric Company, New York, Morris rail bond and hydraulic splicing machine.

National Carbon Company, Clevland, Ohio, primary cells.

Onondago Dynamo Company, Syracuse, N. Y., direct-connected dynamo and electric motors.

Peru Electric Manufacturing Company, Peru, Ind., porcelain insulating devices.

Porter Battery Company, Chicago, storage batteries.

Pyle National Electric Headlight Company, Chicago, electric headlight.

William Roche, New York, dry cells.

Standard Paint Co., New York, P. & B. tape, insulating compound and armature field coil varnish.

Submerged Electric Motor Co., Menominee, Wis., submerged electric motor and propeller.

C. J. Toerring Company, Philadelphia, arc lamps.

Waite & Bartlett Manufacturing Company, New York City, X-ray apparatus.

Wilhelm Telephone Manufacturing Company, Buffalo, telephone apparatus.

Honorable Mention.—American Watchman's Time Detector Company, New York, watchman's time detector.

Arnold Electric Power Station Company, Chicago, power station system and clutches, illustrated by models.

Charles J. Bogue, New York City, electric searchlight.

The Buckeye Electric Company, Cleveland, Ohio, incandescent lamps.

Chicago Fuse, Wire & Manufacturing Company, Chicago, fuse, wires and links.

D'Olier Engineering Company, Philadelphia, switchboard.

Edison Manufacturing Company, Orange, N. J., battery fan motor.

Alvah W. Hall, New York City, automatic advertiser.

The Jandus Electric Company, Cleveland, Ohio, electric fan motor.

Lea Electric Manufacturing Company, Elwood, Ind., enclosed arc lamp.

E. B. Meyrowitz, New York, eye magnet.

Parsell & Weed, New York, model dynamo.

The Robbins & Myers Company, Springfield, Ohio, dynamos and motors.

C. B. Rowell, Buffalo, static electric machines.

F. B. Sage & Brother, New York, direct-reading ohmmeter.

Sprague Electric Company, New York, electric motors.

Stow Manufacturing Company, Binghamton, N. Y., multi-speed motor and flexible shaft.

The O. C. White Company, Worcester, Mass., adjustable lamp arm.

DIVISION XI. TRANSPORTATION.

Jurors.

H. G. Prout, chairman; Arthur V. Abbott, William Aughinbaugh, Albert C. Bostwick, Prof. R. C. Carpenter, J. M. Carson, Jr., Frederick A. Delano, David Porter Heap, C. H. McLellan, Henry M. Paul, Prof. C. H. Peabody, Prof. Geo. D. Shepardson, Ambrose Swasey and J. Elfreth Watkins.

Gold Medals.—Automobile Company of America, New York, automobiles.

J. G. Brill Company, Philadelphia, cars and trucks.

Consolidated Railway, Electric Lighting & Equipment Company, New York, car-lighting system.

De Dion-Bouton Motorette Company, Brooklyn, N. Y., automobiles.

Electric Vehicle Company, New York, automobiles.

General Electric Company, traction apparatus.

Gas Engine & Power Company, and Chas. L. Seabury & Co., Morris Heights, N. Y., launches and engines.

Gould Coupler Company, Depew, N. Y., car-lighting system.

Howard Iron Works, Buffalo, N. Y., elevators.

Locomobile Company of America, New York, automobiles.

Lidgerwood Manufacturing Company, New York, electric ship's winch.

Mobile Company of America, Tarrytown, N. Y., automobiles.

John A. Roebling's Sons Company, Trenton, N. J., general exhibit in Transportation Building.

The Safety Car Heating & Lighting Company, New York, lighting system for cars and buoys.

The Union Switch & Signal Company, Swissvile, Pa., block signal and interlocking apparatus.

Silver Medals.—Bierbaum & Merrick Metal Company, Buffalo, N. Y., Ideal trolley wheel.

Consolidated Car Heating Company, Albany, N. Y., car-heating apparatus.

Gold Car Heater Company, New York, car-heating apparatus.

Gould Coupler Company, Depew, N. Y., car coupler and platforms.

Haynes-Apperson Company, Kokomo, Ind., automobile.

McGuire Manufacturing Company, Chicago, car trucks and appliances, and track sweeper.

Michigan Yacht & Power Company, Detroit, Mich., launch and gasoline engine.

New York Air Brake Company, New York, air brakes.

Overman Automobile Company, New York.

Woods Motor Vehicle Company, Chicago.

Bronze Medals.—Continuous Rail Joint Company of America, Newark, N. J., rail joints.

Chisholm & Moore Manufacturing Company, Cleveland, Ohio, rail joints.

Electric Vehicle Company, New York, gasoline vehicle.

The Kidder Motor Vehicle Company, New Haven, Conn., motor vehicle.

E. R. Thomas Motor Company, Buffalo, N. Y., automobiles.

Weber Railway Joint Manufacturing Company, New York, rail joints.

Honorable Mention.—American Motor Company, New York, launch and motor.

Buffalo (N. Y.) Electric Carriage Company, automobiles.

Morris Electric Company, New York, wheel-truing brake shoe.

Palmer Brothers, Mianus, Conn., gasoline engines and launches.

Stearns Steam Carriage Company, Syracuse, N. Y., automobile.

DIVISION XIII.—MANUFACTURES.

Jurors.

Edmund A. Engler, chairman; William L. Aughinbaugh, Marcus Benjamin, Morris Benson, A. H. Bottum, J. M. Carson, Jr., John L. Choyer, F. W. Clarke, George Coit, Stanley T. Cozzens, John G. Eppendorff, Alberto Falcon, M. L. Floyd, David Porter Heap, W. H. Holmes, John R. Kendrick, F. P. Machado, Edward S. More, Henry M. Paul, Frank H. Peabody, G. G. Pond, W. de C. Ravenel, John K. Rees, Edward Rovinson, Jose A. Saenz, Carlos Sellerier, George D. Shepardson, John Strootman, Ambrose Swansey, Evaldo Tirado, Juan P. Tomas, Chas. H. Turner, Harry Walbridge, Mrs. Lester Wheeler and Miss Hauenstein.

Gold Medals.—American Steel & Wire Company, Chicago, nails and springs.

Berry Brothers, Ltd., Detroit, Mich., varnishes.

The Pantasote Leather Company, New York, imitation leather.

The Pittsburg Reduction Company, Pittsburg, Pa., aluminum.

The Standard Paint Company, New York, Ruberoid roofing and flooring.

J. H. Williams & Company, Brooklyn, N. Y., drop forgings.

Silver Medals.—Columbia Typewriter Manufacturing Company, New York, typewriters.

Cassidy & Son Manufacturing Company, New York, electric fixtures.

I. P. Frink, New York, reflectors.

Ohio Tool Company, Columbus, Ohio, mechanics' tools.

Pratt & Letchworth Company, Buffalo, N. Y., malleable iron and steel castings.

The Standard Paint Company, New York, paints and varnishes.

The O. C. White Company, Worcester, Mass., adjustable electrical fixtures.

Bronze Medals.—The Blickensderfer Typewriter Manufacturing Company, Stamford, Conn., electrical typewriter.

Cosmopolitan Range Company, New York, electric broiler and oven.

Norton Emery Wheel Company, Worcester, Mass., oilstones.

W. C. Vosburgh Manufacturing Company, Ltd., Brooklyn, electric fixtures.

Honorable Mention.—Jenkins Brothers, New York, electromagnetic lamp holder.

Installation.

In addition to the awards for individual exhibits, medals were also presented for excellence of exhibit installations. The medals awarded on this score to exhibitors whose apparatus comes within the scope of this paper were as follows:

Gold Medal.—Edison Manufacturing Company, Orange, N. J.

Silver Medal.—General Electric Company.

Bronze Medal.—Safety Insulated Wire & Cable Company.

Honorable Mention.—American Electric Telephone Company; Buckeye Electric Company and Kellogg Switchboard & Supply Company.

DIVISION XIV.—GRAPHIC ARTS.

Jurors.

Theodore Low De Vinne, chairman; Marcus Benjamin, Julio Perez Canto, Stephen J. Kubel, D. B. Wainwright.

Silver Medal.—Jantz & Leist Electric Company, Cincinnati, Ohio, electrotyper's motor-generator.

Honorable Mention.—Charles J. Bogue, New York, photo-engraving lamp.

The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., printing-press electric controller.

Thomas A. Edison, Orange, N. J., numbering machine.

New England Motor Company, Lowell, Mass., compound motor, type M. E.

DIVISION XV.—LIBERAL ARTS.

Exhibitors *Hors Concours.*

Massachusetts Institute of Technology, Boston, Mass.; president of Institute, chairman of superior jury.

Gold Medals.—Keuffel & Esser Company, New York, surveying instruments and drawing materials.

Pratt Institute, Brooklyn, N. Y., students' work, showing educational methods and results.

Rensselaer Polytechnic Institute, Troy, N. Y., students' work, showing educational methods and results.

John A. Roebling's Sons Company, Trenton, N. J., bridge engineering.

McGraw Publishing Company, New York, American Electrician, Electrical World and Engineer, Street Railway Journal, technical books, etc.

Worcester Polytechnic Institute, Worcester, Mass., students' work, showing educational methods and results.

Silver Medal.—The Western Electrician, Chicago, Ill., publication, The Western Electrician.

Bronze Medal.—International Correspondence Schools, Scranton, Pa., photographs, courses of study, pupils' work.

LEGAL NOTE.

BABCOCK & WILCOX NAME.—In the suit of the Babcock & Wilcox Company against the Joshua Hendy Machine Works a decree has been entered in the United States Circuit Court for the Northern District of California, perpetually enjoining the Joshua Hendy Machine Works, and its officers, agents, etc., from using the name "Babcock & Wilcox," either alone or combined with other word or words, upon, or in connection with the sale or offering for sale of any boiler or other steam apparatus not manufactured by The Babcock & Wilcox Company, and from stating or representing that any boiler or other steam apparatus sold or dealt in by the Hendy Works, and not manufactured by The Babcock & Wilcox Company, is a Babcock & Wilcox boiler; and from selling, or offering for sale, or passing off, any such boiler or other steam apparatus as having been manufactured and sold by The Babcock & Wilcox Company.

OBITUARY.

J. LEE JUDSON, who was for many years engaged in central-station work, died recently at his home in Rochester, N. Y. Mr. Judson was born in 1847, at Cincinnati, Ohio, and after considerable experience in manufacturing interests established by his father, became one of the founders of the Edison Lighting Company of Rochester. The various lighting interests of the city were later consolidated into the Rochester Gas & Electric Company, of which Mr. Judson was made president, and which was extremely successful under his management.

C. WALTON SWOOPE, head of the electrical department of the Spring Garden Institute, Philadelphia, died on October 7, after an illness of five days. Mr. Swoope was only 31 years of age, but he had become well known as an instructor in practical electricity. He was a graduate of the Manual Training School and had had considerable experience in the shops of the old Edison Company at Schenectady. His loss will be keenly felt at the Spring Garden Institute, where he had, by a prodigious amount of personal labor, developed the classes in electricity into a definite department giving complete laboratory instructions to classes aggregating nearly 200 pupils.

ELLIOTT P. GLEASON, whose name is doubtless familiar to every central-station purchasing agent in the country, died recently in his eighty-first year. Mr. Gleason early became interested in the manufacture of gas burners and similar supplies, and made a fortune by perfecting the Argand gas burner. In 1861 he established the business in

New York City which was in 1871 incorporated as the E. P. Gleason Manufacturing Company. When electric lighting developed, his company was one of the first to make fittings and appliances especially designed for that branch of work. Mr. Gleason had the peculiar faculty of knowing personally almost every individual among his 1000 employees, and made the remarkable record of never having a strike in any of his factories, or even a misunderstanding with any of his men. He is survived by two sisters and a brother.

PERSONAL.

MR. GEORGE WESTINGHOUSE sailed for Europe on October 16.

MR. L. C. MAINLAND has been appointed superintendent of the Green Bay (Wis.) Gas & Electric Light Company.

MR. CHARLES A. COFFIN, president of the General Electric Company, returned last month from his recent trip to Europe.

MR. J. M. GRAVES, of Philadelphia, has been appointed electrical and mechanical engineer for the Chicago Insulated Wire Company, Chicago.

MR. W. E. DANIELS, of Chicago, has accepted the position of superintendent of the Manistee (Mich.), East Lake & Filer City Electric Railway Company.

MR. W. R. FLEMING, president of the Harrisburg Foundry & Machine Works, Harrisburg, Pa., is back home again from an extensive business trip throughout Europe.

MR. ARTHUR ROLF, who has been for some months past in Great Britain superintending work for the Bullock Electric Manufacturing Company, returned home on October 10.

MR. JOHN H. FINNEY has been appointed western sales manager for the Stanley Electric Manufacturing Company, Pittsfield, Mass., with headquarters in the Monadnock Block, Chicago. Mr. B. W. Bergenthal will be the resident engineer of the western office.

MR. H. C. ADAMS, JR., who has for several years been secretary of the Phillips Insulated Wire Company, resigned that position recently to take the managership of the New York office of the Peru Electric Manufacturing Company. Mr. Adams entered upon his new duties on November 1.

MR. JAMES FERGUSON, formerly general superintendent of the Municipal Electric Light Company, Brooklyn, and later a division superintendent of the Brooklyn Edison Company, has accepted the position of general superintendent and engineer of the McRoy Clay Works, Brazil, Ind., manufacturers of clay conduit.

MR. GEORGE A. McKINLOCK, president of the Central Electrical Company, Chicago, has the sincere sympathy of the entire electrical fraternity over a serious accident with which Mrs. McKinlock met recently. During the "paper chase" of the Owentsia Club at Lake Forest, Mrs. McKinlock was thrown from a horse and dragged 200 yards, sustaining serious injuries.

MR. ALEXANDER J. WURTS, well known as the inventor of the non-arcing lightning arrester, and more recently as an ardent developer of the Nernst lamp in the interest of the Westinghouse Company, delivered a lecture on the new lamp before the Franklin Institute, Philadelphia, October 16. The lecture was illustrated by a display of Nernst lamps in commercial form and was extremely interesting.

MR. RALPH L. SHAINWALD, president of the Standard Paint Company, New York, has returned from a three months' business tour over Europe, and expresses much gratification at the condition of P. & B. affairs there. The sale of P. & B. materials abroad has constantly increased each year, until they now have come to be quite as familiarly known on the other side of the Atlantic as they are here.

PROF. R. A. SMART has resigned his position in the Department of Experimental Engineering of Purdue University, Lafayette, Ind., in order to accept a position with B. F. Sturtevant Company, Boston, Mass., where he will become the head of a department of experimental engineering which is being established for the purpose of investigating all problems relating to blower practice and of developing new and more efficient applications of the fan blower in all lines of industry.

MR. EDWARD R. GRIER, who has for many years represented the Bryant Electric Company in Chicago, and is well known throughout the West by reason of the excellent results accomplished in his territory, has severed his connection with the Bryant Company and with Mr. Harvey Hubbell, the well-known inventor and manufacturer of Bridgeport, Conn., has organized an electrical manufacturing company to be known as the Hubbell-Grier Electrical Company, for the purpose of enlarging the business in electrical specialties which has been established by Mr. Hubbell.

TRADE PUBLICATIONS.

WHY WE ARE GLAD. The Banner Electric Company, Youngstown, Ohio.—A pamphlet devoted to the merits of the Banner incandescent lamp, which, it is explained, caused the gladness expressed on the outside cover of the pamphlet.

STURTEVANT DIRECT-CURRENT GENERATORS AND MOTORS. B. F. Sturtevant Company, Boston, Mass.—Catalogue No. 117 of standard size, containing well-executed engravings of Sturtevant generating sets and motors, together with descriptions and dimensional data relating to these machines.

MINIATURE LAMPS. General Electric Company.—This is the General Electric Company's publication No. 1035, the subject matter of which is indicated by the title. In addition to illustrations and descriptions of miniature lamps and sockets of G. E. manufacture, the book contains a great deal of valuable matter relating to the selection and care of such lamps.

THREE-WIRE SECONDARY DISTRIBUTION. Pittsburg Transformer Company, Pittsburg, Pa.—Bulletin No. 7, containing information relating to the company's new transformer winding for three-wire secondary distribution. This winding was described in the September number of the American Electrician, and the matter there given forms a part of the contents of the pamphlet in hand.

GASOLINE FURNACES AND TORCHES. Clayton & Lambert Manufacturing Company, Detroit, Mich.—A pamphlet catalogue containing illustrations and descriptions of the complete line of the appliances made by this company. The line is a comprehensive one, embracing furnaces and torches for every conceivable class of work.

CONCERNING WET GOODS. James Beggs & Co., New York.—Notwithstanding its title, this publication does not relate to means of exhilaration, but is devoted to the Potter mesh separator and superheater, which was described in the October number of this paper. The pamphlet is illustrated and the description is lucid and interesting.

GOULD STORAGE BATTERY FEATURES. The Gould Storage Battery Company, New York.—An artistic pamphlet containing illustrations of the features referred to, and strong arguments, together with convincing presentations of these features in simple, direct language, the conciseness of which adds greatly to the strength of the arguments presented.

GREEN'S FUEL ECONOMIZER. The Green Fuel Economizer Company, Matteawan, N. Y.—This is a superbly-executed brochure, containing an illustrated description of the economizer and all of its parts, together with some interesting pictures of economizer installations and instructive charts showing the results of tests made on plants equipped with these economizers.

NORTHERN MOTORS IN MACHINE SHOPS. Northern Electrical Manufacturing Company, Madison, Wis.—This is Catalogue No. 6, of standard size, devoted to the application of Northern motors to machine tools and machine-shop service. The catalogue is handsomely executed, and the contents make interesting reading irrespective of their advertising merit, which is high.

A COMMUTATOR NECESSITY.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.
50c. per Stick. $5.00 per Dozen.

For Sale by all Supply Houses.
Upon receipt of this coupon we will send FREE, sample stick.

Name..
Address..
A. E.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO.

TRY THIS SIMPLE EXPERIMENT. The Shelby Electric Company, Shelby, Ohio.—A card bearing at its top the catchy legend here reprinted, and containing an illustration of the experiment which the company advises lamp users to try. This consists in holding a book beneath a suspended lamp and noting the difference between the illumination given out by the Shelby lamp and that obtained from lamps of other types.

◆

BUSINESS NEWS.

THE CROCKER-WHEELER COMPANY announces that its New York office has been placed under the management of Mr. Francis B. De Gress. Mail for this office should be addressed to the Crocker-Wheeler Company, New York Branch, 39 Cortlandt Street.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., has opened a branch office in the New England Building, 129 Euclid Avenue, Cleveland, Ohio, which has been placed in charge of Alexander T. Moore, district manager for the company in that section.

THE SPRAGUE ELECTRIC COMPANY, New York, recently held its annual meeting and re-elected the following officers for the ensuing year: John Markle, president; Edward C. Platt, first vice-president; Allan C. Bakewell, second vice-president; Harry R. Swartz, secretary and treasurer.

VARLEY DUPLEX MAGNET COMPANY, Philipsdale, R. I., announces that its Chicago office has been removed from the Fisher Building to 82 Lake Street. C. L. Hibbard, western agent for the company, states that his office will carry a much larger stock of Varley products than heretofore.

THE SHULTZ BELTING COMPANY, St. Louis, Mo., has been compelled by reason of enormous increase in business to add to its already large factory plant, the addition comprising three new buildings, one of them 160 x 150 ft. and four stories high, and the other two 40 x 75 ft. and two stories high.

THE CONSOLIDATED SCHOOLS.—The United Correspondence Schools, the Institute of Home Study of Engineering, and the Correspondence School of Technology, have been combined under the title of The Consolidated Schools, with headquarters at 156 Fifth Avenue, New York, in charge of F. A. Ewald.

THE BAY STATE ELECTRIC COMPANY has recently started in business at 164 Federal Street, Boston, Mass. The company announces that it will do a general electrical construction business, and will make a specialty of repairing motors, commutators and armatures, and also the rewinding of armatures. Mr. W. H. Bird, formerly with the Thomson-Houston Company, is associated with this company.

THE HAZELTON BOILER COMPANY, whose general offices were formerly located at 120 Liberty Street, New York, has removed the offices to the works at Rutherford, N. J. Rutherford is only nine miles from New York on the Erie Railroad, and there is, of course, frequent railroad service during the day, so that the offices are almost as accessible to anyone visiting this city as they were before the removal.

THE SIGNALOID CHEMICAL WORKS, formerly known as the Phoenix Chemical Works, manufacturers of coloring and frosting compounds for incandescent electric lamps and other decorative glass work, have been meeting with such a gratifying demand for their specialties that their old quarters in Brooklyn were found too restricted, and they have recently moved into a new factory at 167 and 169 Clendenny Avenue, Jersey City, N. J., where increased facilities will enable them to take care of all orders promptly.

THE CHICAGO BOILER CLEANER COMPANY, of Pittsburg, Chicago and St. Louis, was succeeded on November 1 by the Liberty Manufacturing Company, with offices at the same places as heretofore. The new company will continue to manufacture cleaners, filters and other specialties, under the same management and with practically the same officers as before. The company's business not only extends to nearly all the best firms in America, but to leading European manufacturers, and in fact to all parts of the world.

THE LAMBERT SCHMIDT TELEPHONE MANUFACTURING COMPANY, New York, advises us of the closing of a contract with the Manhattan Elevated Railway Company for a complete exchange telephone system to be used in connection with the operation of the elevated roads. Instruments will be located at the various stations and offices and will displace the telegraph instruments now in use. The equipment will consist of a 500-line multiple switchboard to be operated on the common battery plant with lamp signals, together with the usual sub-station apparatus. The details of the equipment will include a good many new features, the character of the plant differing widely in many respects from an ordinary exchange plant.

ROSSITER, MacGOVERN & CO., New York, have made some changes in the personnel of their official staff which are considered to put the firm in a better position than ever for the transaction of their extensive business in the purchase and sale of electrical and steam machinery and apparatus. Most important among these changes is the election of Clinton L. Rossiter, for many years president of the Brooklyn Rapid Transit Company, to the presidency of the firm under discussion. Mr. Rossiter's

The Tolophono Service is The Quickost Mossongor.

Rates in Manhattan from $5 A MONTH. One Year Contracts. Monthly Payments.

NEW YORK TELEPHONE CO.
15 Dey Street. 111 West 38th Street.

CREAM FLUX

An Absolutely Non-Corrosive Insulating Soldering Flux FOR ALL METALS.

So EASILY APPLIED that all CAN USE IT.
So CHEAP that all SHOULD USE IT.
So EFFICIENT that all MUST USE IT.

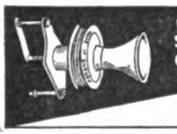
PUT UP IN CANS AT
15c., 25c., 45c. and 75c.
SPECIAL PRICES IN QUANTITY.
SEND FOR TRIAL BOX.

Endorsed by the National Board of Fire Underwriters and all users.
We guarantee it, and if not satisfactory, money will be refunded.

FOR SALE BY ALL SUPPLY HOUSES OR

CREAM FLUX CO., SOLE MANUFACTURERS, 100 Washington St., **CHICAGO**

BIG STICK, 35 CENTS.
Sample Free.
SOUTHWORTH & HARE,
Indianapolis, Ind.



GENUINE ERICSSON SWEDISH COAL-GRAIN.
MICROPHONE
THE PERFECT TRANSMITTER.
No Packing. No Adjusting. No Trouble.—Also Complete Line Long Distance Telephones.
Ericsson Telephone Company, 296 Broadway, N.Y.

NOTICE The Third Edition of the large **GREEN BOOK** of Hardware Specialties is completely exhausted. We have however, a few more of the little **GREEN BOOK** o Hardware Specialties on hand, which we will be pleased to send on application.

SMITH & HEMENWAY CO.
Utica Drop Forge and Tool Co.
Ask your dealer for these goods. 296 Broadway, New York City

An INCANDESCENT LAMP represents a large investment of capital, ingenuity and skilled workmanship, it is sold at a price so low as to necessitate eternal vigilance in cutting costs to a minimum. A successful lamp manufacturer can not afford to experiment with poor materials. This explains the popularity of

BAKER & CO.'S PLATINUM
408 N. J. R. R. Ave., NEWARK, N. J. 120 LIBERTY ST., NEW YORK
We buy and Refine Platinum Scrap also

experience as president of one of the largest street-railway systems in the country has given him a thorough knowledge of the railway situation, and the possibilities of development in that field, and this, coupled with his naturally fine executive ability, cannot fail to be of great advantage to his firm, to the business of which he will hereafter devote a great deal of personal attention. Vice-President Frank MacGovern is so well known and highly thought of in engineering circles that any discussion of his genial personality and indefatigable energy would be superfluous. The firm have increased their capital stock considerably, and intend to greatly enlarge the scope of their business; they have already established a branch office and warehouse at St. Louis, and a similar branch will be established at Cincinnati.

F. B. SAGE & BRO., New York, have been appointed agents for this city and the vicinity for the well-known Hylo lamps made by the Phelps Company, Detroit, Mich.

THE HEINE SAFETY BOILER COMPANY, St. Louis, Mo., reports a strong demand for its boilers in foreign countries, notably South Africa, Australia and New Zealand.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, reports an important shipment of Cross oil filters recently to Stockholm, Sweden. The company states that these filters are now in use in 28 countries.

THE BRITISH THOMSON-HOUSTON COMPANY, LTD., of England, has removed its general offices from 83 Cannon Street, London, to the new works at Rugby, where all communications should be addressed in future.

THE ELECTRIC MOTOR & EQUIPMENT COMPANY, Newark, N. J., reports a rapidly increasing demand for the Brewster receptacle, which was illustrated and described in a recent issue of this paper.

THE O. K. SPECIALTY MANUFACTURING COMPANY, Garrettsville, Ohio, announces a brisk business in its tablet boards, combination switch cut-outs and time switches, which appear to have met with decided approval among the trade.

THE STILWELL-BIERCE & SMITH-VAILE COMPANY, Dayton, Ohio, reports shipments of Stilwell feed-water heaters to the Austin (Tex.) Rapid Transit Company, Kankakee (Ill.) Electric Railway Company and Boonville (Ind.) Electric Light and Power Company.

MARSHALL-SANDERS COMPANY, Boston, announces that it is in position now to fill orders for Midget plugs and receptacles, a description of which will be found in our New Apparatus department, and its new Baby knife switches, having doubled the factory capacity to meet the demands for these specialties.

BARKELEW ELECTRIC MANUFACTURING COMPANY, Middletown, Ohio, has just put on the market a new style of knife switch which is known as Type S. The switch is built to fulfill all of the Underwriters' requirements, and the manufacturers have sufficient confidence in it to send it on approval to any responsible dealer or user.

CENTRAL ELECTRIC COMPANY, Chicago, reports an extremely gratifying business in D. & W. appliances. This line includes junction boxes, street car and stationary motor safety cut-outs, transformer and car heater safety cut-outs, subway boxes, feeder blocks, service switches, etc., equipped with D. & W. non-arcing fuses.

HOLOPHANE GLASS COMPANY, New York, is justly gratified in the amount of attention and character of encomiums its glassware is obtaining. Holophane globes were awarded the John Scott medal by the Franklin Institute, two gold medals and a silver medal at the Paris Exposition and a gold medal at the Pan-American Exposition.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., has found it necessary to add a new building to its Milwaukee factory, giving an additional floor space of 8000 sq. ft., so that the total factory floor space now aggregates about 55,000 sq. ft. It is scarcely necessary to point out that the company devotes its attention exclusively to the manufacture of rheostats and circuit-breakers.

THE STURTEVANT COMPANY EXPANDING.—Work is now under way upon the foundations for the immense new plant of the B. F. Sturtevant Company at Hyde Park, Mass. That the buildings can be completed none too soon for the urgent needs of the company is indicated by the fact that the present plant at Jamaica Plain is now taxed to the limit, so that it has been necessary to run overtime, particularly in the engine and electrical departments.

THE KELLOGG SWITCHBOARD & SUPPLY COMPANY, Chicago, reports a very satisfactory year in its pole business. The company entered the field about January of the present year, and secured from producers in the vicinity of Escanaba, Mich., a very large stock of white cedar poles, with the idea of furnishing telephone companies with them in connection with its switchboard and telephone business. It furnished a large number of poles for the Independent plants at Jackson and Detroit, Michigan; Columbus, Ohio, and also made heavy shipments for the new plants now being constructed at Alliance and Canton, Ohio. It was, of course, an experiment for a telephone manufacturing company to enter heavily upon a branch such as the pole business, but the results have been so satisfactory, and worked in so well with its general business, that they have decided to continue for another year.

THE H. C. ROBERTS ELECTRIC SUPPLY COMPANY, Philadelphia, has accepted the agency for Whitney electrical instruments, and has put in a stock comprising a full line of regular sizes. The company has also been appointed agent for the Mica Insulator Company, New York, for that company's line, comprising micanite plates, Empire cloth, oil papers, etc. The placing of both of these agencies is a matter of considerable pride to the Roberts Company, the Whitney agency being placed without solicitation, and the Mica Insulator agency being the only one, it is said, that has ever been placed with a supply house. Some of the other special agencies held by the Roberts Company are those of the Bryant Electric Company, Emerson Electric Manufacturing Company, Adams-Bagnall Electric Company, and Gardiner Electric Drill Company.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, states that its fall business has opened up in a most satisfactory manner. This is especially true of the apparatus department, which has never before been so busy. The company is exclusive agent for the Warren Electric Manufacturing Company, Sandusky, Ohio, the Eddy Electric Manufacturing Company, Windsor Conn., Moloney Electric Company, St. Louis, and for the sale of Adams-Bagnall arc lamps. In connection with the apparatus department the company has a fully-equipped engineering department, which is prepared to draw up plans and specifications for lighting plants, and in fact give any information or data necessary for the proposed installation of electric light and power plants. The company reports that it is meeting with fine success in the sale of the new type Scheeffer watt meter, which has been considerably improved.

SOLID TRAINS TO NORTHERN MICHIGAN.

The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches. through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

A New Book. Latest American Practice.

ELECTRIC
GAS LIGHTING.

How to install Electric Gas Igniting Apparatus, by H. S. Norrie. Send for full descriptive circulars—free.

SPON & CHAMBERLAIN,
12 Cortlandt Street, New York.

THE MASON
Reducing Valves

ARE THE WORLD'S STANDARD VALVES

For automatically reducing and absolutely maintaining an even steam or air pressure.

They are adapted for every need and guaranteed to work perfectly in every instance.

Write for full information and splendid references.

THE MASON REGULATOR CO. Boston, Mass., U. S. A.

American Electrician.

Vol. XIII. New York, December, 1901. No. 12.

A MODEL SMALL CENTRAL STATION.

THE MUNICIPAL LIGHTING PLANT AT WAPPINGER'S FALLS, N. Y.

BY C. W. OBERT.

The municipal central station at Wappinger's Falls, N. Y., presents an excellent demonstration of the economy, convenience and simplicity obtainable by supplying a mixed service from alternating-current generating machinery, using only the one type of generator. This plant also serves to demonstrate that the advantages of uni-type generating apparatus are not confined to large stations.

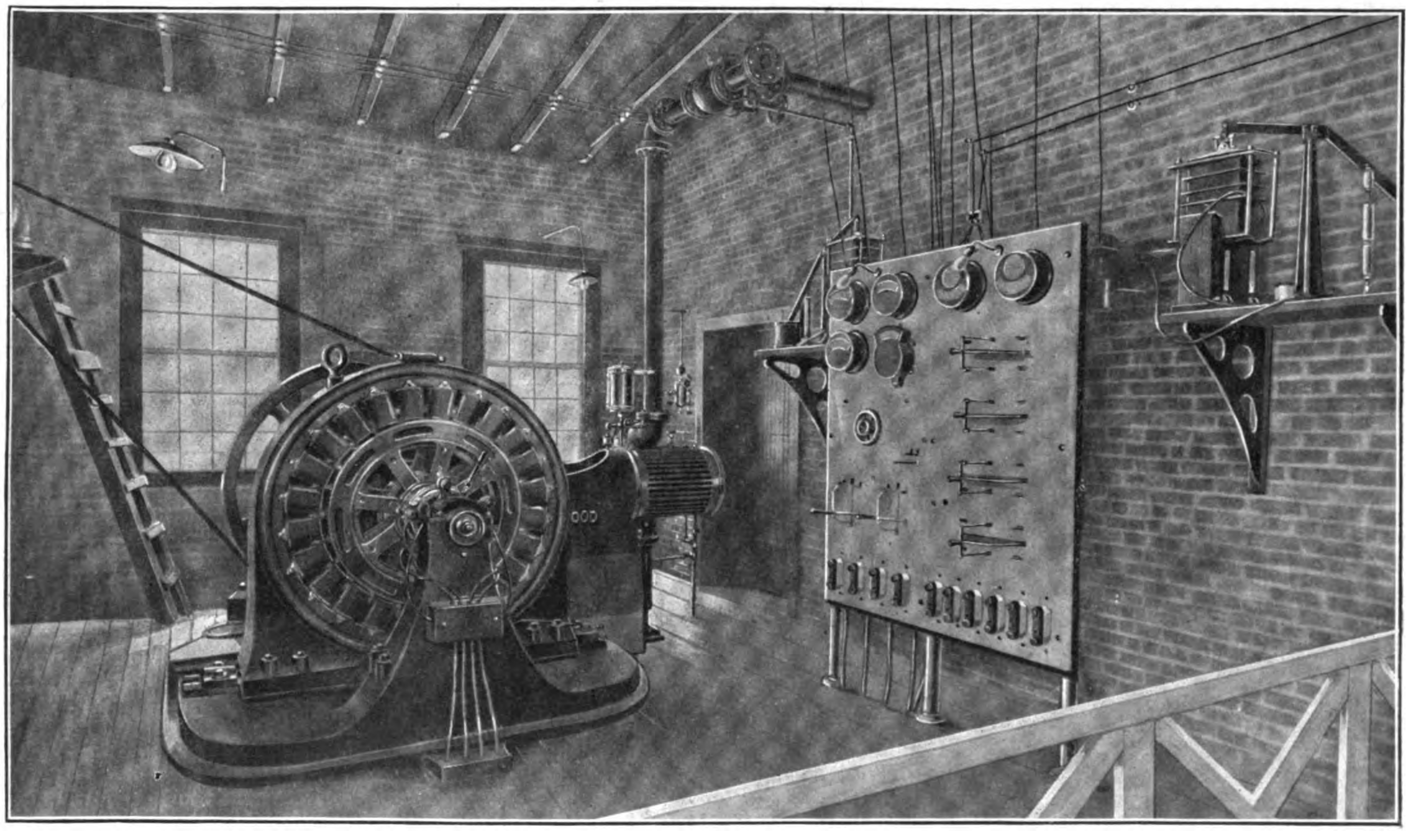


FIG. 1.—VIEW IN GENERATING ROOM, WAPPINGER'S FALLS LIGHTING PLANT.

The station building is located on the bank of Wappinger's Creek, about half a mile from the center of the village and adjacent to coal dockage, which site was chosen on account of the abundant free water supply. The building is of brick and is divided into two parts, an engine room, 30 ft. x 17 ft., with 14-ft. pitch, and a boiler room, 30 ft. x 40 ft., with 16-ft. pitch, the partition wall being also of brick. The building was built of sufficient size in both boiler and engine rooms to allow additional boiler and generating plant to be installed whenever an extension in capacity is necessary.

The boiler at present installed is an ordinary horizontal return tubular boiler, 16 ft. long and 66 ins. in diameter. It has 985 sq. ft. of heating surface and is designed for a working pressure of 125 lbs. per sq. in. The boiler is mounted in the usual manner in a substantial setting of 24-in. walls; a walk-way or alley 20 ins. wide was left between the side wall of the setting and the wall of the building, and a clear space 30 ins. wide between the back end of the setting and the end wall of the building for access to the back of the boiler. The blow-off cock is located at the front end of the boiler and the blow-off pipe runs down and under the floor out to the discharge point. The chimney is of steel, 30 ins. in diameter and 60 ft. high; it rests directly on the flue connection at the front of the boiler and is guyed in the usual way.

A swinging damper in the flue connection is controlled by a Kellar improved draft regulator, which is conveniently located on the brickwork at the side of the setting. The regulator is adjusted to open the damper at 82 lbs. pressure of steam and close it when the pressure reaches 83 lbs.; it maintains the pressure at 82½ lbs. for hours at a time under normal conditions of load and firing. The coal used under the boiler is a mixture of anthracite pea and buckwheat, the pea coal alone being used, however, in firing up. The water of the creek adjacent, which is used for boiler feed, is found to be sufficiently clean to render washing out the boiler necessary only once every eight weeks. In addition to the main boiler a small "donkey" boiler of eight nominal horse-power is installed in the boiler room to supply steam when the main boiler is shut down for repairs or cleaning. By this means the main boiler may be washed out and filled again with ease in the absence of a city water-works system, the pump or injector being run by steam from the donkey boiler. The donkey boiler is of the vertical fire-tube type, and is supplied with an independent stack, injector, etc.

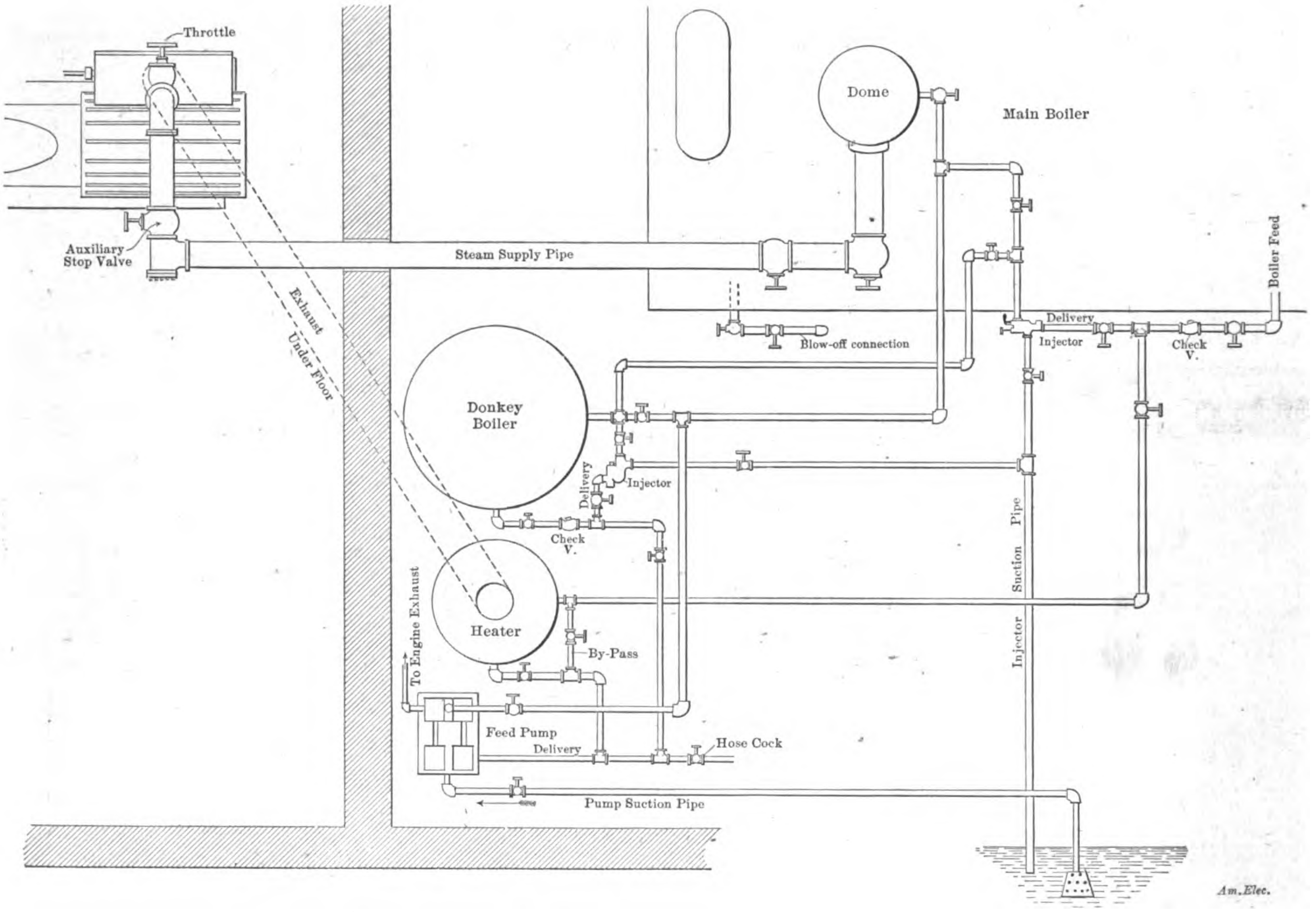


FIG. 2.—DIAGRAM OF PIPING AND CONNECTIONS OF STEAM AUXILIARIES.

The main boiler is fed by a Blake duplex pump, which is of sufficient size to supply both the present boiler and another one of similar size in case of future extension. The suction of the pump has an 18-ft. rise from the average water level in the creek. The feed pump discharge passes to the boiler through a return-copper-coil feed-water heater, made by Jas. L. Robertson & Sons, New York; under ordinary conditions of running this heater delivers the feed water at a temperature of about 205° F. As a safeguard in case of possible accident to the pump an injector is provided for both the main boiler and the "donkey." The injectors, which are the well-known Metropolitan machines made by the Hayden & Derby Manufacturing Company, New York, have a common suction running down to the bed of the creek separate from the pump suction, in order to secure absolute independence and maximum security against accident to the water supply.

The piping and connections of the steam auxiliaries are shown in the diagram, Fig. 2. As may be seen therefrom, the steam piping is so arranged that both the main boiler's injector and the feed pump may at will be run by steam from either the main boiler or the donkey boiler. The pump discharge is so piped that it may feed either the main or the donkey boiler, and the feed for the main boiler may be by-passed around the feed-water heater. The exhaust from the pump is piped into the exhaust from the main engine. The usual hose connection is provided in the pump delivery pipe for the cooling of ashes, washing out, etc.

The steam main leads out from the dome of the boiler through an angle valve first and then through a straight globe valve, this double valve arrangement being provided in view of future extension, where the two boilers are to supply steam to the one header. The steam supply pipe terminates at a tee in the engine room, one outlet of this tee being blanked off and the opposite outlet delivering steam through an auxiliary stop valve to the throttle valve of the engine. The blanked side of the tee will eventually be connected to a steam header. The joints in this steam main are all of the flange type and drips are provided at several points to remove water. The one feature in which the plant fails to meet modern requirements is in the absence of pipe covering of any sort to prevent the serious heat losses by radiation.

A simple, automatic cut-off engine of the well-known Ball & Wood make is direct-connected to the alternator, which rests upon an extension of the engine base. The cylinder is 13 ins. in diameter, with a 12-in. stroke, the engine being rated at 125 horse-power at 100 lbs. steam pressure and a speed of 300 r.p.m. The engine is of the self-oiling type, and the oil is filtered and used over and over again. Cylinder lubrication is cared for by a Detroit standard sight-feed lubricator, of the usual double connection type. The engine bed rests upon a very solid foundation of brick laid in Portland cement. The exhaust pipe runs from the engine beneath the floor and out into the boiler room, where it enters the feed-water heater from below, discharging from above through the usual outboard exhaust pipe extending upward through the roof.

The generator is a 75-kw. two-phase Westinghouse alternator, direct-driven by the engine, the armature being pressed on an extension of the engine shaft. The machine is compound-wound, the usual rectifying commutator being provided to supply the series coils. It delivers current to a four-wire two-phase distribution system at 2200 volts and 60 cycles. The armature is of the closed-winding type, 30 ins. in diameter, and revolves at a peripheral speed of only 2357 ft. per minute; the field magnet has 24 poles, the rate of rotation being 300 r.p.m. The exciter is a 15-kw. direct-current Westinghouse dynamo delivering current at 125 volts and running at a speed of 1300 r.p.m. It is a four-pole machine and is mounted upon brackets on the side wall of the engine room nearest the engine flywheel, to which it is belted. Fig. 3 shows diagrammatically the connections of the switchboard, the front of which appears at the right of the front page engraving. The switchboard consists of two panels of white marble, 1½ ins. thick, each panel being 20 x 72 ins. in size. The panels are mounted on an angle-iron framework standing 2 ft. out from the wall, and the bottoms of the panels clear the floor by 18 ins. The generator panel contains the usual equipment, comprising main fuses, two main switches, the rheostats and exciter connections, a voltmeter, two ammeters and a ground detector. The main leads from the generator are carried under the floor to the switchboard, where they pass through the semi-enclosed fuses, shown at the bottom of the panel, and then lead to the bus-bars through the two main switches, as shown in the diagram, Fig. 3. Between each main switch and its bus is an ammeter, *A*, located at the top of the dynamo panel. Under the left-hand ammeter is the voltmeter, which, of course, may be shifted over to read from either phase. Both ammeters and the voltmeter are Whitney instruments, supplied by Machado & Roller, New York. Below the right-hand ammeter (shown at the right of the ammeters in the sketch) is a General Electric ground detector, arranged for use on either phase, and below this is the knife switch which controls the main exciter circuit; in the center of the board are the rheostats for the shunt fields of the exciter and the alternator. These rheostats are of the enamel type, situated behind the board, the operating hand-wheels and spindles of which are concentrically arranged on the front of the board, as shown in the center of the panel in Fig. 1. The main switches, as well as those on the distributing panel, were made by the Crouse-Hinds Electric Company, Syracuse, N. Y. The blades of the switches give a break distance of 6 ins., with a separation of parts of opposite polarity of 5 ins.

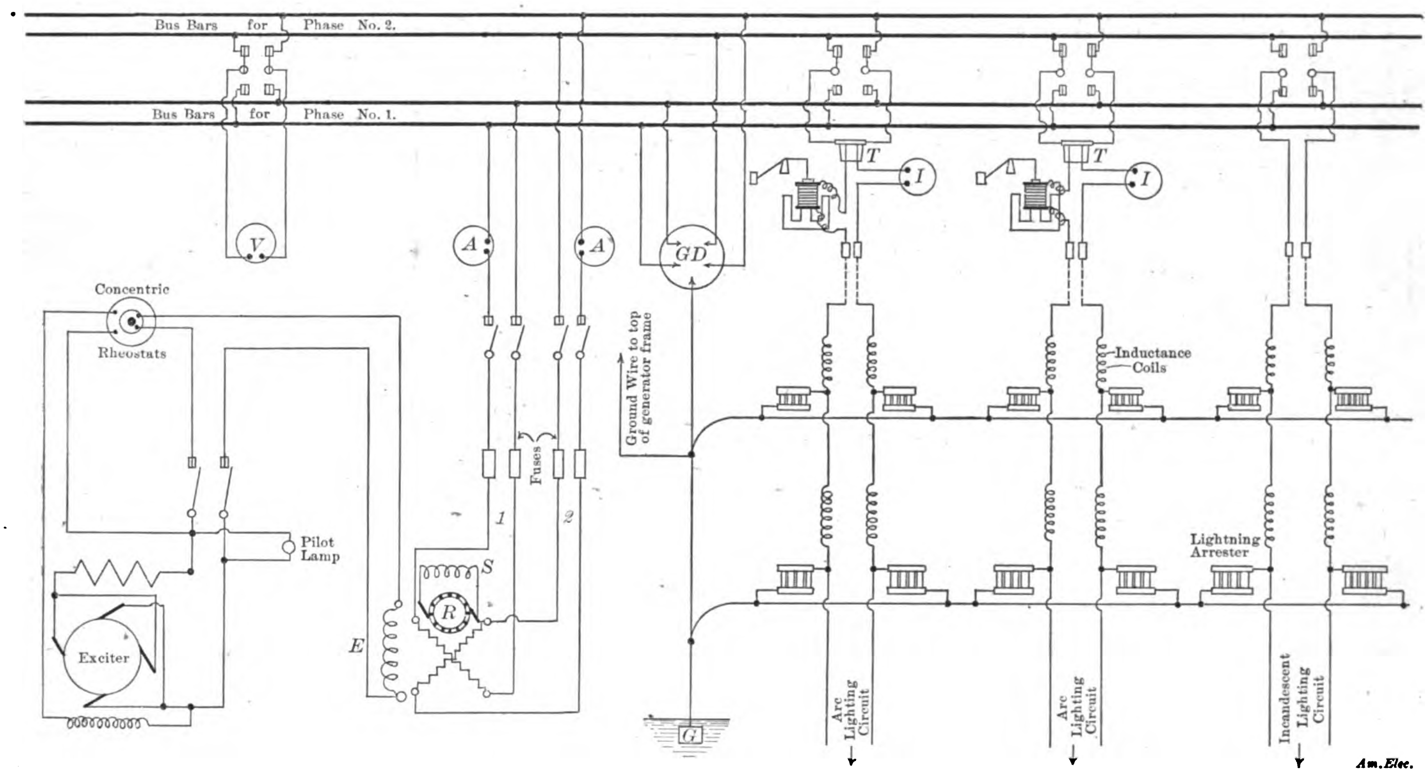


FIG. 3.—DIAGRAM OF SWITCHBOARD CONNECTIONS.

The distributing panel contains, at the top, two current indicators, *I I*, four double-throw switches and the circuit fuses. The current indicators are Whitney instruments. The upper double-throw switch on this panel, as shown in Fig. 1, is the voltmeter switch, by which the voltmeter may be thrown on either phase. The switch next below it controls the single commercial incandescent lighting circuit that is now run from the station, and the two lower switches control the two arc lighting circuits. The switches are double-throw, in order to put any circuit on either phase. The fuses at the bottom of the board, of which two are for each of the three circuits, are also of the semi-enclosed type. The bus-bars (behind the board) are flat copper strips ⅛ x ¾ in. in section, the main connections being strips of 3/32-in. x ⅝-in. section.

The arc lighting circuits are supplied from two step-up transformers, the current being kept constant by means of floating-coil reactive regulators, built by the Manhattan General Construction Company, Newark, N. J. The step-up transformers are located within the station and regulators are mounted on shelves at the sides of the switchboard, as shown in Fig. 1. Each circuit contains 26 enclosed arc lamps of the series alternating type, made by the Manhattan General Construction Company. These are suspended on ⅝-in. stranded cable cross spans from Cutter patent weatherproof pulleys.

Special precautions were taken to protect the lines from lightning by a very elaborate installation of Wurts non-arcing lightning arresters. At the station two separate banks of arresters are provided, one outside the station at the ends of the pole lines and the other just inside the station, and in each line is inserted two inductance coils, one between the two arresters and the other between the first arrester and the switchboard, as shown diagrammatically in Fig. 3. Banks of arresters are also distributed along the lines in different parts of the town.

The commercial service is supplied in the usual way by transformers delivering 104 volts at their secondaries and the service is supplied on meter. The line wires, which are of No. 8 B. & S. gauge, are carried on a well-constructed and guyed pole line, heavy glass insulators being used. The arc lighting service is done on the moonlight schedule. No motor load is thus far carried, but the plant was made two-phase so that motor service might be supplied when the demand for it shall be developed. The compact and simple arrangement of the plant makes it capable of being handled successfully by one man, except in extreme emergencies. The plant was installed by W. M. Sheehan & Co., of New York.

ROTARY CONVERTERS.

BY A. S. M'ALLISTER.

In external appearance a polyphase rotary converter resembles a direct-current generator with a conspicuously large commutator and an auxiliary set of collector rings. Its design in certain respects is a compromise between alternating-current and direct-current practice. This is most noticeable with reference to the speed and number of poles; that is, the frequency. A careful review of constructive data for modern direct-current railway generators reveals the fact that the frequency of such machines is between 8 and 12 cycles while the frequency of the older belted type was about 20 cycles. Alternating-current generators, on the contrary, when not limited in frequency, are seldom built for less than 60 cycles.

Since the rotary converter is in fact a synchronous motor, it must run at a speed determined by the alternations of the supply and the number of its poles. A limit to the possible increase in speed of the converter is set by the peripheral speed of the commutator. Experience has demonstrated that 3000 ft. per minute is as high as the commutator should run to give reliable service. The peripheral speed of a rotary converter is equal to the product of the number of alternations by the distance between two adjacent neutral points. For a given direct-current e.m.f., a limiting potential difference of from 8 to 10 volts, between segments, and the minimum size of bars, allowing for insulation, it is evident that, with a limiting peripheral speed, there is soon reached a limit to the number of alternations. While, under the limits noted, it is possible to construct 500-volt rotary converters for 60 cycles, good design has determined that 25 cycles is the proper frequency for converter work at such pressure.

Since the direct and alternating currents flow in the same windings, revolving in the same field, it will be appreciated that the direct-current voltage bears a constant ratio to the alternating voltage; the maximum value of the internal alternating e.m.f. being equal to the direct-current e.m.f. The effective value of the alternating e.m.f. observed will depend upon the form of the e.m.f. wave and upon the points on the windings between which the voltage is taken. Assuming a sine wave and denoting the direct-current e.m.f. by 1, the effective alternating e.m.f. is about 0.71 for two-phase machines and star-connected six phasers, and about 0.61 for three-phase and delta-connected six-phase machines. The wave form, and hence this ratio, can be materially changed by altering the slope of the pole-faces.

For most satisfactory and economical operation, the rotary converter wave should correspond to that of the system. The counter e.m.f. of the converter, both as to wave form and magnitude, must be equal to that of the supply system. If the converter does not tend of itself to produce a wave similar and equal to that of the system, corrective currents will flow in the armature windings, which currents so react upon the field that the generated e.m.f. will have a wave form exactly the same as that of the supply. As far as converter output is concerned, these corrective currents are wattless. They, however, affect the regulation of the system and waste energy in the resistance of the connecting circuits and should therefore be eliminated when possible.

If the converter is excited to give an e.m.f. less than that of the system when it is running at the speed at which the alternations of the supply designate that it must run, a lagging current will be drawn from the system, which current tends to strengthen the motor field so that the generated e.m.f. is made equal to that of the system. Similarly, if the converter field is overexcited, the current drawn from the supply mains will be leading and will thus demagnetize the field sufficiently to make the e.m.f. equal to that of the system. It is thus plain that the current demanded depends upon the field excitation and will be least for that excitation which would cause the machine to generate an e.m.f., when running at normal speed, equal to that of the system.

The mean speed of the converter must equal the mean speed of the generator, but the instantaneous speeds of the two may be quite different, as will be seen later. The synchronizing current, which holds the converter in step with the system, tends to cause the converter to follow any irregularity in the frequency of the supply-current.

The tendency to irregular angular velocity in each revolution is inherent in the construction of reciprocating engines and is augmented by the periodic hunting of the governors of engines operating alternators in parallel. The inertia of the converter armature causes it to tend to run at a constant speed, and if the alternations of the supply are irregular, during a portion of the time the converter will be ahead of the system, and at other times it will be lagging behind. During the time of relative phase displacement between the converter armature and the system, the synchronizing current acts to draw the armature into perfect step. If additional forces are brought to bear upon the converter during the period of phase shifting, the relative oscillations may be either increased or decreased according to the time-direction of such forces.

This action is very similar to the swinging of a pendulum. If, when the swing is in one direction there is given it an impulse in the same direction, the amplitude of the swing is increased, and if the impulse is given in the opposite direction, the amplitude is diminished. The periodic hunting of the engine governor, the steam admissions, the momentum of the reciprocating parts, the inertia of the generator armature and that of the converter armature, are elements which tend to increase or diminish this oscillation.

Much theoretical and experimental work was undergone before a complete cure for the tendency to this periodic phase shifting was found. Among the methods at present used may be mentioned the heavy flywheel effect for the converter, and a magnetically weak armature compared with the field. In either of these cases, the converter armature tends to revolve at a mean speed independent of the relative irregularity of the frequency of the supply.

The method which has been found most satisfactory for the prevention of hunting of rotary converters is the use of damping devices. These are usually of the form of copper shields between or surrounding the poles, often covering a portion of the pole-tip or even imbedded in the pole proper. As the armature oscillates back and forth across its normal position, the shifting armature magnetism, produced by the unconverted portion of the motor current, induces current in the low-resistance copper shields, which current always opposes the shifting magnetism producing it. The damping action thus brought into play when the field is suddenly distorted has the effect of suppressing the oscillations. When the alternations of the supply are irregular, the damping devices act to cause the converter to tend to follow the irregularities, but prevent an exaggeration of the momentary phase displacement of the armature and thus have a steadying effect upon the whole system.

Before a rotary can be placed into active service, it must be brought up to synchronous speed and into step with the supply system. Methods in use for accomplishing this result are as follows:

(1). Since polyphase currents are universally used as supply, the application of the alternating currents directly to the stationary armature without field excitation will result in a rotating magnetic field about the armature core. The eddy currents thereby induced in the pole-faces will exert a torque on the armature and cause it to tend to speed up to synchronism. Under the condition of starting, the step-up transformer relation between the field and armature windings causes a relatively large e.m.f. to be generated in each field coil. To lessen danger from this source, the windings on the separate poles may be isolated from each other so that the e.m.f. generated in the coils will not be in the normal series relation, and thus the total e.m.f. across any two points may be limited to that generated in one pole winding alone. When a shunt to the series coils is used, it must be opened at starting, otherwise the heavy alternating current sent through it and the series coils may cause excessive heating.

(2). Where the station equipment will permit, the converter may be started up as a direct-current motor. The direct current may be obtained from a storage battery, from another converter or a motor-generator set may be installed for this purpose. A device for automatically tripping the direct-current circuit-breaker upon closing the alternating-current switch has proved a valuable addition to the equipment for converters started by this method.

(3). A method extensively employed by one of the leading manufacturing companies is the use of separate motors for starting one or more of the converters of the sub-station equipment. The motors may conveniently be of the induction type and therefore started by standard methods for this purpose. A common location for the induction motor secondary is upon an extension of the converter shaft. Since the induction motor must experience a slip of some value, it is necessary, in order to bring the converter to full synchronism, that the motor shall have a less number of magnet poles than the converter.

In street railway and similar work it is always desirable to increase the station pressure as the load comes on, in order that the line voltage shall remain more nearly constant. The dependence of the direct-current voltage of the converter upon that of the alternating supply has been commented upon. In order, therefore, to increase the pressure of the output it is necessary to increase the pressure of the supply also. This increase may be obtained by the use of variable-ratio step-down transformers, or by the insertion of reactance in the supply circuit and running the load current through a few turns around the field.

We have found previously that if the converter be overexcited, leading currents will be drawn from the supply, while if the excitation is below normal, lagging currents will be drawn. If a lagging current be drawn through a reactance, the collector ring voltage will be lowered. If, however, leading current be drawn through the reactance the voltage will be raised. The change in the phase of the current to the converter is governed by the excitation, which is in turn regulated by the load current, so that, with series reactance, the effect of the series coils on the field of the converter is quite similar to that of the compounding on the ordinary direct-current railway generator. In operation it is sometimes found that the transmission line and converter circuits possess sufficient self induction so that additional reactance is unnecessary.

The operation of a rotary converter is in general much more satisfactory than that of a corresponding direct-current generator. This is due to several causes: (1). Absence of field distortion; the rotary is both a generator and a motor. As a generator the armature current tends to distort the field in a direction opposite to the distortion as a motor. The effects of the armature reactions, therefore, neutralize each other, and since there is no shifting of the field, the point of commutation does not vary with the load, and sparkless commutation results. (2). Lessened friction loss. (3). Greater output from same armature. Since the load current at portions of each revolution feeds directly from the alternating-current side without traversing the whole winding, as must be the case with a generator, the effective armature resistance is less than it is for the same armature used in a generator.

The ratio of effective to true armature resistance depends upon the number of phases. If *Ra* represents the true armature resistance, and *R* the effective armature resistance, and we assume the full-load rating of the machine to be governed wholly by the heating of the armature conductors, then the output current will be greater as a rotary converter than as a generator by the ratio.

$$\sqrt{\frac{Ra}{R}}$$

The value of $\frac{Ra}{R}$ and $\sqrt{\frac{Ra}{R}}$ are as follows:

	$\frac{Ra}{R}$	$\sqrt{\frac{Ra}{R}}$
Three-phase rotaries	1.78	1.334
Quarter-phase rotaries.....	2.7	1.643
Six-phase rotaries..........	3.85	1.962

The above facts bring forward another of equal importance. It is evident from the figures just given that an armature of a converter connected up six-phase will give a much larger output than when used three-phase. The theoretical ratio is about 1 to 1.47. In practice this would be slightly modified by wattless currents, if such be present.

The first thought of the use of six-phase converters suggests numerous complications of connections, which, upon further investigation, are found not to exist. With reference to the converter proper, the only change necessary is the addition of three more collector rings at a very small expense.

The six-phase currents can be obtained directly from the secondaries of the three-phase step-down transformers. For this purpose there should be three separate single-phase transformers with primaries connected delta (for reasons to be subsequently given). Each secondary should consist of two independent coils, and from these six coils should be formed two independent delta-connected three-phase circuits, using one coil from each secondary for each delta, having due regard for phase relations.

An examination of the connections of a six-phase armature will reveal the fact that, if only alternate rings be considered, neglecting for the moment the additional three rings, we have a true three-phase armature. Now considering only the other three rings alone, we have again a true three-phase armature. Further examination will show that at any given instant the e.m.f. between two rings of one set chosen as above, is in direct phase opposition to the e.m.f. between the corresponding two rings of the other set; this is true of each pair of rings of each set. We therefore find that the three-phase e.m.f. in one set is displaced just 180 degrees from the three-phase e.m.f. in the other set. The connections to obtain six-phase currents from the two independent three-phase circuits are obvious from this explanation.

Modern practice has fully demonstrated the advisability of connecting the polyphase side of each rotary converter permanently to the low-potential side of the step-down transformers without the intervention of fuses, switches or other instruments, by conductors of the least possible length. The addition of three conductors between the rotary converter and the transformers, therefore, introduces practically no complexity of circuits.

The delta connection of transformers offers a decided advantage over the star connection from the fact that in case of one transformer being crippled, the other two will successfully carry the load, with some additional heating, however. If three delta-connected transformers be equally loaded until each carries 100 amperes, there will be 173 amperes in each external circuit wire. If one transformer be now removed and 173 amperes continues to be supplied to each external circuit wire, each of the remaining transformers must carry 173 amperes, since it is now in series with an external circuit. Therefore, each transformer must now show three times as much copper loss as when all three transformers were active, or the total copper loss is now increased to a value of six relative to its former value of three.

The rotary converter is an entirely reversible piece of apparatus. If fed with alternating current of a certain voltage, it will supply direct current of a corresponding (not equal) voltage, and similarly, if fed with direct current it will deliver alternating current of corresponding voltage. When operated to convert from direct to alternating current, the rotary is called by the somewhat ill-chosen term "inverted converter."

When driven by alternating currents its speed is governed by the alternations of the supply quite independent of all other conditions. When run from the direct-current side, however, its speed is determined by the relation of its field strength and impressed e.m.f. at the brushes. It operates in this respect exactly like a direct-current motor. If the field from any cause becomes weakened, the converter will speed up until its armature conductors cut the field magnetism at a rate to generate an e.m.f. equal to the internal impressed e.m.f. If the field be strengthened the speed will be correspondingly decreased. Obviously, therefore, the frequency of the alternating-current output may be quite irregular, though the e.m.f. be constant, if the field fluctuates in strength.

As far as the alternating-current output is concerned, the inverted converter operates as a generator. In an alternating-current generator, lagging currents weaken the field, while leading currents have the opposite effect. With constant external field excitation, the running strength of the field will, therefore, depend upon the character of the alternating-current load. When used to supply power for induction motors and similar apparatus, the current drawn will have a lagging component which weakens the field and tends to increased speed. Safety to the converter and motors necessitates that the increase in speed be limited, while satisfactory service requires that this tendency be counter-balanced.

The following methods are in use for overcoming the tendency to irregular speed:

(1). Magnetically weak armature compared with the field. It is possible by this method to operate a converter on full zero power factor current without very materially weakening the field.

(2). Separate field excitation supplied from a direct-current generator driven synchronously with the converter. Any increase in converter speed causes the exciter generator to supply more field current and thus counteracts the influence of the lagging armature current. This latter arrangement can be made to regulate for very small variations in speed by operating the exciter field below saturation and the converter field at a high magnetic density and having the converter armature relatively magnetically weak. A very slight increase in speed causes a large increase in field current, while at the same time the armature current has a small demagnetizing effect upon the field.

BRICK CHIMNEYS FOR POWER STATIONS.

BY WILLIAM D. ENNIS.

The chimney, as a part of central-station equipment, is unique. It seldom exists in divided units and is often without reserve capacity. It is absolutely essential to commercial operation. Its failure means an inevitable shut-down. It is architecturally the most prominent and the distinguishing feature of the plant. It is in many cases planned without proper consideration of the work to be done; and yet requires for satisfactory performance as much of expert designing as does the piping, boiler setting or condensing apparatus.

The proportions of a chimney are determined with reference to the following points: Kind and grade of fuel, amount of fuel burned per hour, type and dimensions of furnace, boiler and setting, arrangement and size of flues, average temperature and limits of temperature of the external air, elevation of the plant above sea-level, variation of atmospheric humidity and limiting dimensions of the chimney itself.

A chimney may be rated on a horse-power basis, the boiler horse-power being equivalent to the evaporation of 34½ lbs. per hour at the pressure and temperature of unconfined boiling water. Such a rating is given on page 735 of Mr. Kent's "Mechanical Engineer's Pocket Book," and the assumption is made therein that 6.9 lbs. of water will be evaporated by a pound of coal. This is a conservative figure, and for a small power station the table mentioned is a safe one to use. Boiler horse-power should not be assumed as equivalent to the horse-power of the engines supplied by steam, however, but should be based solely on the amount of water evaporated.

For a proposed plant, in which the average evaporation can only be estimated, the chimney should be designed with reference to the units of steam consumption. For this purpose the consumption of steam in pounds per indicated horse-power per hour may be assumed to be 17½ for compound-condensing engines, 23½ for simple condensing engines, 30 for simple non-condensing engines, 40 to 70 for uneconomical, throttling or slide-valve engines, and 100 for direct-acting simple steam pumps. The indicated horse-power of the engines can, of course, be determined from the proposed electrical output, making a proper allowance for the efficiency of generators and mechanical efficiency of the engines. The safest way of estimating the indicated horse-power of a steam pump is to consider the mean effective pressure equal to one-half the boiler pressure, adding 50 per cent to the tabulated piston speed for the proposed duty.

Having in this way calculated the probable steam consumption of the plant, add to the total 10 per cent to cover losses by condensation, leakage, etc., and consider the sum to be the amount of steam that the boilers must furnish. The amount of coal that must be burned to generate this steam may be ascertained from a knowledge of the heating values of the particular grades of coal to be used. This gives the fundamental factor in the data for a proposed chimney. If the amount of coal thus found to be required per hour is divided by 5, Kent's table, above mentioned, will be applicable under the limitations already stated.

Before fixing upon the size of chimney for the given plant, the question of possible future enlargement should be considered, and space for another chimney should be provided, unless the first chimney is made large enough for any probable future rate of fuel consumption. If the output is increased by forcing the boilers instead of by installing additional boilers, the fuel consumption and size of chimney will be increased in more than direct proportion. Allowance should be made also for occasional supplies of poor coal, in which case a rigidly proportioned chimney might be inadequate. The chimney can never be too large for economical operation of the plant.

While engaged in designing the chimney, the engineer must consider any possible retardation of the fuel gases in their escape from the furnace. and compensate for such, if necessary, by increasing the height of the chimney. Such retardation may occur at the bridge wall, the rear arch, tubes, bonnets or flues. Sharp turns also interfere with draft, as do rough surfaces or projections into fuel-gas spaces. Leaks in boiler settings, fire doors, smoke connections or flues should, of course, be stopped.

The grate area has an important bearing on the subject. If it be too small, coal will be burned at low efficiency, and consequently more coal will be used and more gases must be carried off. The ratio of grate surface to heating surface should be maintained at standard proportions in use for the specified type of boiler and grade of coal.

Draft is caused by a difference in density between the chimney gases and the external air. As the density of air differs with its temperature, this difference of density is greater and the draft is better when the external air is cold. For this reason smaller chimneys may be used for plants at high latitudes and elevations than for those where the temperature may run above 90°. The density of the external air is also affected by the proportion of humidity and by the elevation. At the sea-level, where the atmospheric pressure is normally equal to 29.92 ins. of mercury, the draft would be much better than on a high mountain, where the air is rare and of a density nearer that of the flue gases.

Final determining factors are those with regard to the construction of the chimney itself. A horizontal flue entering a vertical chimney causes a retardation of the flow of gases at the sharp bend. A square core chimney is less effective than one with a round core. Internal stiffening ribs, ladders and projections of any kind, retard the draft, as do also some forms of ostensibly ornamental top copings and cornices.

In general the chimney area may safely be calculated with regard simply to the kind and amount of fuel under ordinary conditions and in emergencies or under increased output; while the height which determines the draft should be fixed with reference to all of the factors discussed. As the cost of chimneys increases rapidly with increase of height, very high chimneys should be avoided, and two or more of moderate size preferably installed. (This does not apply to metallurgical or chemical plant chimneys, but only to those designed for use in connection with steam-power plants.)

For a station of average size a good brick chimney will cost, completed, in the neighborhood of New York, about $15 per thousand bricks contained. The number of bricks per horse-power will vary largely with the economy of design. A tyro would probably use 50 per cent more material than a competent builder, without gaining additional strength. One chimney, built for 8000 boiler horse-power, 10 ft. in diameter, 225 ft. high, with an independent inner core, contained 700,000 bricks above the ground line. Another 5 ft. 6 ins. in inside diameter, 125 ft. high, contained 230,000 bricks. A chimney built for 3000 boiler horse-power contained 450,000 bricks. A blast-furnace chimney, without inner core, octagonal, with a round shaft 10 ft. in diameter, 125 ft. high, contained 165,000 bricks. All these figures are exclusive of concrete foundations.

The cost of concrete or stone foundations will vary with the location, and with the grades and proportions of material used. In the neighborhood of New York broken stone of suitable size for concreting costs from $1 to $2 per cubic yard; sand, from 75 cents to $1.50 per cubic yard; Portland cement (domestic), from $1.75 to $2.50 per barrel, imported about $3 per barrel; all prices including delivery. A cubic yard of Portland cement concrete will therefore represent a material cost of from $1.65 to $3, and the labor for excavating and laying may be as much more. The average figure will probably be $5 per cubic yard complete. Rough stone masonry may cost less than this if the stone is at hand.

Brick for chimney construction should be of first-class quality, sound throughout, and not too light. Second-quality pressed brick makes a good material for chimneys of moderate height and cost. All racks and corbels should be laid in full cement. It is well to use full cement also for the lower courses, to and including the flue opening. Firebrick, if used as an interior lining, should be laid in fire-mortar, and will add considerably to the expense.

Cast-iron work for clean-out doors and frames, top-cap, etc., should not cost over 4½ cents per pound, delivered, including patterns, under present conditions; 5 cents per pound will cover cost of forgings, bolts and hangers, for a ladder.

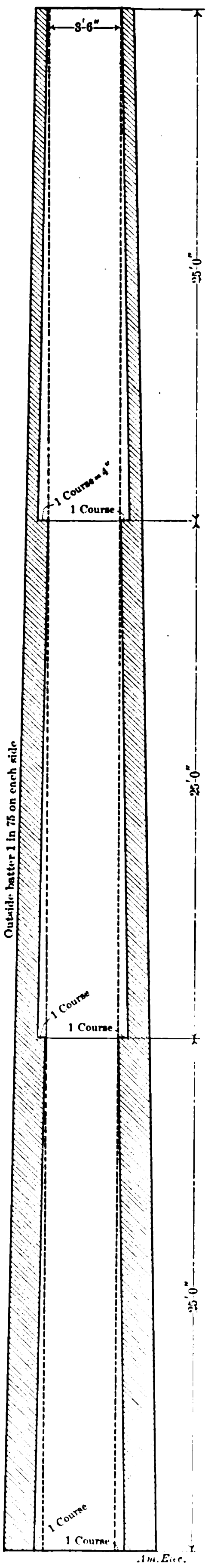


FIG. 1.

The first step in designing for construction a proposed brick chimney is to fix the diameter and height, the latter being the difference in elevation of the grates and the top of the shaft. The remaining dimensions and proportions may be figured directly from these two, due regard being given to the features of site, surrounding buildings and connections.

Laying off a center line for the chimney flue, the proportions may be indicated as follows: The thickness of walls should be two courses of brick down to a distance of 20 ft. from the top. Below this a three-course wall may be run for another 20 ft. The remaining structure should increase in thickness at least one brick every 30 ft.; reference now being made to round or square chimneys and stretcher courses of brickwork. Laying off a distance equal to the full diameter of the chimney core, a circle may be described representing the inside diameter at the top of the shaft. The diameter of the outside of the shaft at the top will be equal to this plus the width of four stretcher courses. A cross-section of the chimney should be started and the inside and outside walls on both sides of the center line at the top of the shaft marked. The next step is to determine the batter or slope of the sides. A standard is 1 in 36 on each side, or a total of 1 in 18. This makes a convenient batter for chimneys with an independent inner core, as the off-sets on the outside of the inner core and the inside of the shell will maintain a reasonable amount of clearance when spaced as specified. A chimney without an inner core, if off-set one course inside every 25 ft. of height, would have an outside batter of 1 in 75 when the inner edges of the off-sets are plumb, as indicated in Fig. 1. A double-shell chimney with off-sets of 4 ins. and an outside batter of 1 in 36 on each side is shown in Fig. 2.

In designing a chimney with an inner core, the diameter of the latter is, of course, the effective diameter of the chimney. If the inner core runs to the full height, which is very rarely the case, the outside diameter of the shell at the top, which is the starting point of the batter line, must be laid off with the thickness of the core and shell and the amount of clearance, both in view. The core thickness is sometimes cut down to a single course for a few feet at the top. It should be off-set at least one course, or 4 ins., in every 40 ft. The amount of clearance should be such that the outward off-sets of the core and the inward off-sets of the shell may never be within less than 2 ins. of each other. The core being hotter, will expand to a greater extent than the shell, and if the two can by any possibility become attached, a fracture will occur.

The question of clearance between core and shell is somewhat complicated when internal stiffening is used on the latter. This stiffening usually takes the form of radial projections inward, as shown in Fig. 3. These add greatly to the strength and reduce the necessary thickness of wall.

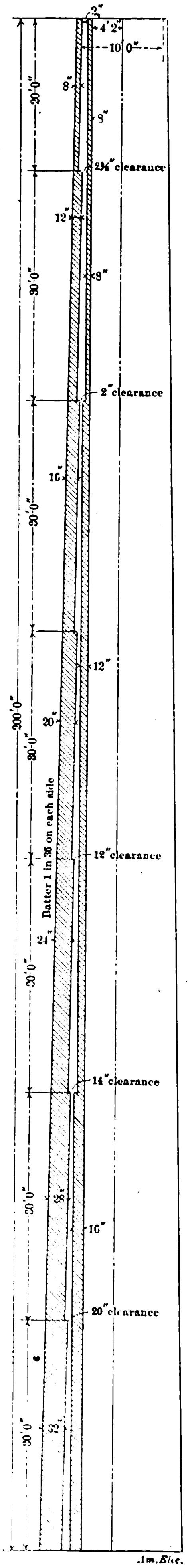


FIG. 2.—DOUBLE-SHELL CHIMNEY.

In addition, the shell is usually racked out to cover the top of the clearance space, as shown in Fig. 4. This racking should not be too close to the top of the core, however, or else the expansion of the latter will cause interference.

The foregoing discussion has dealt particularly with round chimneys. This form is one most generally in use, as combining maximum strength with a minimum of complication and construction. Small-sized chimneys are often made square inside and out. A square chimney with a round shaft is extremely stable, and this construction is often used for the lower part of a large chimney, the exterior tapering to octagonal or round at from one-tenth to one-fifth the height. One of the best forms of chimney is the octagonal with a round shaft. The vertices of the octagon form what are practically outside longitudinal stiffening ribs. Specially formed brick can be procured for making the octagonal corners.

The function of an inner core is, of course, to increase the efficiency of draft by providing an insulating envelope of air around the hot gases, retarding the transmission of heat from the gases to the external atmosphere through the chimney walls. The same object is secured in a different manner by the use of hollow brick, which is becoming frequent. Round chimneys are frequently built of radial brick; but a radial solid brick is hardly a necessity except for very small shafts.

At the entrance of

a horizontal flue to a single or double-shell chimney, care must be taken to secure adequate strength and good tight joints. The flue should enter the chimney at such a point that the chimney center line will exactly bisect its area. The top of the opening should be strongly arched. If the chimney has an inner core the arch should be continuous from the outside of the shell to the inside of the core, and should consist of at least four stretcher courses in thickness over its unprotected length between the core and the shell. The brickwork within this air space must be absolutely tight.

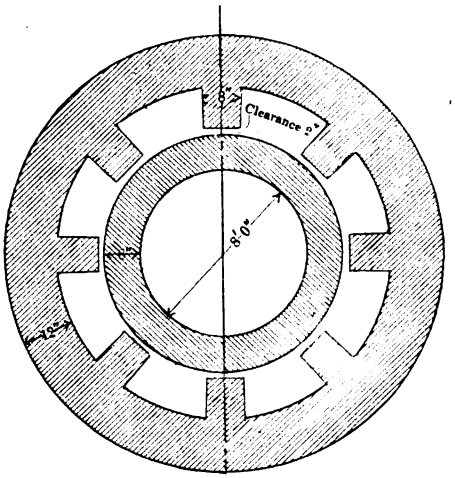


FIG. 3.—INTERNAL STIFFENING PROJECTIONS.

Chimney foundations are built according to the same principles as those for any structure other than machinery. They should rest, if possible, on solid natural earth; if necessary, on piles. The foundation courses should be battered liberally, so as to give a bearing surface equal in area to from four to ten times the area of the chimney itself, and may be of either concrete stone masonry or brickwork, the former being ordinarily preferred.

The architectural details of a chimney are few, being usually confined to the few feet next the top, where a slight degree of ornamentation is permissible. It is a good general rule to follow the features of the building cornices in designing a chimney to be erected in connection with an existing building. One of the most important points to be remembered is that the apparent size of these details will be greatly diminished when they are erected at an elevation of a hundred feet or more. It is therefore well to work with bold strokes in planning ornamental work of this kind. Dentil courses, for instance, which, at a building cornice, might be composed of single row-lock, should, when on top of a high chimney, be increased to three headers, or even, occasionally, to five or six stretchers. Whatever the design, the consideration of artistic effect should not lead to such unstable construction as to make it likely that some day a brick or two would topple off. A heavy course of stonework near the top of the chimney cornice is an excellent means of solidifying the work at this point.

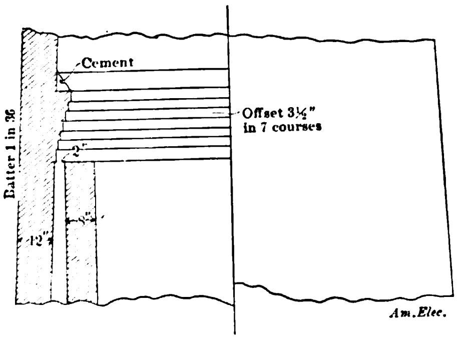


FIG. 4.—RACKING OVER CLEARANCE.

At the very top of the chimney a heavy iron cap should be placed, and this should project down into the core and over the cornice to a sufficient extent to make room for the necessary anchor bolts. The upper surface of the casting should pitch in toward the chimney core, so that when it rains the accumulated soot will be washed down and out of sight, rather than over the outside of the shell. The metal of the cap is usually about ½ in. thick.

A clean-out door should be of ample size, in large chimneys sufficient to permit of the passage of a man with a wheelbarrow. It should give access both to the inner core and the air space between core and shell, and the door between core and air space must be tight. Sometimes two clean-out openings are provided, one of which is cut directly through to the core, while the other merely pierces the shell. Care should be taken not to weaken the chimney by too much cutting away of its wall for flue and clean-out openings.

Ladders may be either internal or external. The former are sometimes preferred because they are out of sight; but an external ladder may be built so as to be by no means a blemish upon the appearance of the chimney. The preferable type is that which has side bars for the guidance of the hands, and it should extend over the top of the chimney, being bent out to clear the cornice. The rungs should be set out a sufficient distance to permit of climbing either outside with the face to the chimney, or inside with the face turned outward. At the cornice, where the ladder pitches out, one rung should be omitted to permit of an outside climber slipping through, in order to avoid climbing with his back downward; and a similar omission should be made at the top so that he may again slip through. The rail should here be extended a sufficient distance to furnish some support to a person working on the top of the chimney. Whatever the design of the ladder, the greatest pains should be taken to make its connections and supports absolutely secure. The slightest defect may mean the death of some one. The bars supporting the rungs or the rung-hooks are usually set in the wall during the construction of the chimney. If the side rails are attached at the same time, provision should be made for the setting of the cement and the difference in the expansion of the brick and iron. Lightning protection for a chimney is always desirable. Provision for it involves no principles different from those observed in all other cases.

ON THE USE OF ZINC IN BOILERS.

BY R. A. DOUGLASS.

Zinc is often recommended for preventing the formation of scale in steam boilers, but it is probable that a considerable portion of the steam users who have tried it would be inclined to report that it is of no value for this purpose. The reason for this disagreement is that zinc is often used under a profound misapprehension of what it can do, and under conditions where it could not reasonably be expected to be of any benefit whatever. It is never of any special benefit for the removal or prevention of what is correctly described as scale, but it is often of great service in preventing the destruction of the plates and tubes of a boiler from the action of a feed water that contains elements of a corrosive nature. Scale, properly so-called, consists of matter that is held in solution, or in suspension, by the feed water when it is introduced into the boiler. The material of which it is composed may be entirely harmless so far as any chemical action upon the boiler is concerned, and the only objection to it may be, and usually is, that it lodges upon the heating surfaces and, if not removed, causes these surfaces to become overheated and burned. It also acts to a certain extent as a non-conductor of heat, and diminishes the efficiency of the boiler by making the surfaces upon which it falls less capable of absorbing heat, but although this last action is undeniably real, its importance is greatly overestimated in the books that treat of these matters. The main objection to what is correctly known as boiler scale consists in its liability to injure the boiler.

The lime, magnesia and other such substances that the feed water may contain in solution are not volatile, and therefore they remain behind as the water boils away, and unless they are removed from time to time, by blowing down the boiler or by opening it and cleaning it out by hand, they are bound to accumulate and make trouble. It must be evident that a difficulty of this sort cannot possibly be remedied by suspending a piece of zinc, or of anything else, in the boiler. The solid matter is there, and zinc will not make it vanish nor change it into anything that will get out of the boiler in any automatic or mysterious way. Yet this is apparently what is expected of it in some cases. Mr. Ridgley, who is United States Consul at Malaga, recently sent a report to this government in which he refers to the use of zinc in boilers, and he states that by its use "the incrustation of the boilers is avoided, and at small cost"; and his report has been quoted with seeming approval by some of the leading technical journals of this country, although, as has been pointed out, the use of zinc cannot be expected to diminish the formation of incrustation in any marked degree, at any rate.

It sometimes happens that a feed water must be used which contains impurities which experience has shown will cause the wasting of the plates of the boilers by chemical action, or corrosion. In such cases as this zinc is often very useful. The action of the zinc is commonly supposed to be of a galvanic nature, and the theory is that when it is hung in the water in the boiler and is connected with the boiler by a good conductor like a piece of copper wire, the combination of the water, the zinc, and the material of the boiler, acts like a voltaic battery, and the zinc is consumed in the place of the metal of which the boiler is constructed. There is some question whether this is just the way in which the zinc acts, because if this were the whole story it might reasonably be expected that the action would cease when the electrical connection between the zinc and the boiler became interrupted. Now the action certainly is diminished when the connection between the two is broken, but it does not appear to entirely cease; and therefore it is highly probable that the galvanic theory of its efficacy is only a partial explanation.

As a rule, then, it will do no particular good to use zinc when the only observed trouble is the formation of scale or the deposit of sediment. If, on the other hand, a tendency toward the actual corrosion of the plates or tubes of the boiler is observed, then, as the doctors say, it may be that "zinc is indicated"; though even in these cases the trouble is sometimes more simply and positively removed by making the feed water alkaline with soda ash. When zinc is used, it should be suspended below the water line; and beneath the zinc, but preferably not in metallic contact with it, a pan of some sort should be placed, so that any particles of zinc oxide that may be formed will fall into the pan and be kept away from the boiler plates. (Zinc oxide and scale matter sometimes form an obstinate sludge, which is apt to adhere closely to the plates and cause local overheating. Hence the suggestion about the pan to catch any fragments that may fall off.) The zinc should be attached to the boiler by means of a copper wire, preferably running up into the steam space and making a good electrical connection with the boiler there. It will be found that when the zinc is put in in this manner it will gradually oxidize, swelling up considerably meanwhile, and will eventually become converted into a spongy mass entirely devoid of any metallic character. When it has been reduced to this form, it should be removed, and a fresh piece should be introduced.

It may be found that the zinc protects the metal of the boiler in its own vicinity, but that the corrosion still goes on in more distant parts of the boiler. In this case, the obvious remedy is to introduce several pieces of zinc, each being connected with the boiler as described, and each being provided with its own separate catch-pan. Pig zinc is sometimes too spongy to be serviceable in boilers, and for this reason rolled or compressed plates or blocks should be used when they can be had. The wire making connection with the zinc should be cast into the pig, when cast zinc is used, and when a zinc block is used, a good connection, which will last until the zinc is nearly used up, may be made by drilling and threading a deep hole in the piece and screwing the connecting wire into it. If wire big enough for this purpose is not available, a piece of copper or iron may be tapped into the hole in the zinc, and the wire may then be connected to the projecting end of this auxiliary piece.

A single word of caution may be offered concerning the use of zinc. It occasionally happens when cast iron fittings are used near the zinc, that these fittings become converted into a soft, almost spongy condition. This action is very uncommon and its cause is not known; but it is always well when using zinc near such cast fittings to keep an eye upon them, in order that they may not deteriorate without the fact becoming known.

ONE OF THE OLD-TIMERS.

BY ARTHUR B. WEEKS,

In out-of-the-way places, scattered here and there throughout the country, are occasionally met some of the antiquated relics of the early days of electrical engineering, still doing active service, and as good as when first installed. The accompanying cut shows one of the earliest types of Brush Electric arc-light machines, now doing duty as a motor in a bicycle repair shop at Niagara Falls, N. Y. Only twice in the history of this machine (built probably about the year 1882) have any repairs been needful; and then only the rewinding of an armature bobbin.

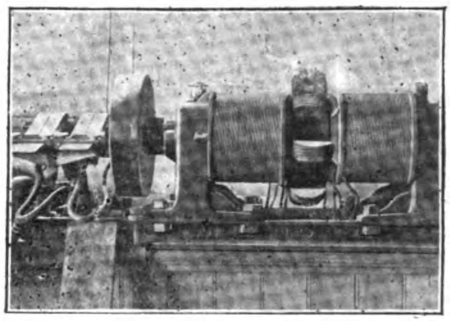


FIG. 1.—BRUSH ARC-LIGHT DYNAMO SERVING AS A MOTOR.

The illustration will call to mind many a familiar sight and pleasant incident to the "boys" once connected with the erstwhile thriving and prosperous Brush Electric Company, of Cleveland, Ohio, which began operations early in the eighties; and will greet the eyes of many as the likeness of an old friend. As is well known, the Short electric-railway motor was but a modification of this machine; improvements being added from time to time, until the multi-circuit brush arc machine as now manufactured by the General Electric Company is the outcome.

In the early eighties, the 3-h.p. motor here illustrated was brought down to Niagara Falls and exhibited on the stage of Park Theater, at an electric-light convention. It was afterward returned to Buffalo, where its present owner found it later, stored away in a dark cellar and covered with rubbish, and purchased it for the sum of thirty-five dollars. He talks enthusiastically of its merits, and regards it with evident pride, and even affection, preferring it to any more modern make; though from an economical standpoint it is, of course, not as desirable.

In the shop operated by this motor are a drill press, lathe, machine saw and a band saw. It is very sensitive to load changes, even the extra load due to a hot bearing on the line of shafting being manifested by a slowing up of the machine. To take a cut off a piece of steel of large diameter in the lathe it is necessary to get a lower rate of speed than normal. To accomplish this the owner of the shop resorts to the unique and rather expensive course of setting all the machines in motion at once, so that the required slowness of speed is attained.

Though this motor is not as economical doubtless as those of the present day, surely none of these later products could withstand the severe and prolonged duties of this early output from the works of the old Brush Company, of Cleveland.

A SIMPLE METHOD OF CALIBRATING A VOLTMETER.

BY J. ROWLAND BROWN.

It is frequently found that switchboard voltmeters of the less expensive type, when compared with a high-grade standard instrument are considerably out of calibration for some cause other than a bent pointer or an incorrect mounting of the instrument. When the trouble is due to either of these causes it is indicated by the failure of the needle to stand at zero when the instrument is disconnected from the circuit. The writer recently had occasion to calibrate an instrument of this sort, and was confronted by the problem of obtaining small gradations in voltage without having a variable source of e.m.f. or a finely graduated resistance box. The method that was resorted to is illustrated diagrammatically by the accompanying sketch, which is almost self-explanatory.

The switchboard instrument was connected up in parallel, of course, with the standard instrument for checking, and the two were connected to a source of current through an improvised water rheostat, consisting of an ordinary wooden pail containing two stationary terminals, *A* and *B*, the one lying on the bottom of the pail, and the other suspended permanently just below the surface of the water. The connections with the voltmeters are clearly shown by the diagram, from which it will be seen that the instruments were not connected simply in series with the water rheostat. Salt was added to the water in the pail until the ammeter in series with it showed 5 amperes.

The scale of the incorrect voltmeter was covered with a piece of white paper on the edges of which were made three marks corresponding to three marks made on the old scale. The zero reading was taken, and a mark was made beneath the pointer on the blank scale card. The bare end of the exploring wire connected to one side of both instruments was then dipped in the water close to the terminal *A* and adjusted until the standard voltmeter needle stood precisely at the first scale division. This reading was then marked on the blank scale card of the switchboard instrument and the exploring wire was lowered a trifle toward the terminal *B* until the standard voltmeter indicated the next scale division, which was similarly marked on the blank scale card of the switchboard instrument, and so on until the instrument was completely calibrated. When the exploring wire touched the terminal *B* the standard voltmeter indicated, of course, the full voltage of the generator, which was made as high as possible by cutting out all the field resistance.

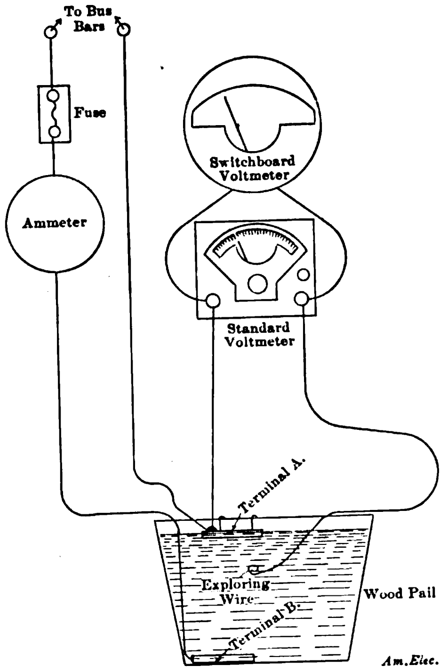


FIG 1.—DIAGRAM OF CONNECTIONS FOR CALIBRATING A VOLTMETER.

The new scale was then removed from the switchboard voltmeter and taken to the drawing room, where a copy was made in ink and the figures inked in. The new scale was then pasted over the old one, taking care that the three marks on the edges corresponded precisely to the three marks on the old scale. It is not necessary, of course, to make the current through the water resistance precisely 5 amperes; any other value will do just as well, but this proved to be a convenient current in the case mentioned, and it is important to keep the current value below the point where the water in the pail begins to become turbulent. An assistant is necessary, of course, either to manipulate the exploring wire or to mark the voltmeter scale.

TRANSVERSE STRESSES IN STEAM PIPES.

BY A. S. MANN.

RELATIVE LENGTHS OF MAINS AND BRANCHES.

When a piece of flat iron is laid across two supports and a load is applied to the center of its length, it is expected to deflect in accordance with accepted laws, and if its modulus of rupture is known it is expected to break when the load reaches a certain definite amount. These laws do not discriminate as to the shape of the beam. They are just as true for an I-section as for a square section, and it is to be expected that a hollow cylindrical section will obey the same laws. It is true that not many transverse tests have been made upon pipe. But the metal of which the pipe is made is not unlike that of any rolled beam, or of any piece of boiler plate, and until experiments on full-sized pipe tested with transverse loads shall have been made, and of such number that they may be taken to represent average results, there seems to be no reason why the constants for iron and steel may not be applied to these cases and the results accepted as the best obtainable.

Unless otherwise noted, 28,000,000 lbs. per square inch will be taken as the modulus of elasticity for the metal throughout this discussion, and 16,000 lbs. per square inch as the safe working strength. This latter figure gives a factor of safety of between 3 and 4, and is chosen because of the impossibility of the transverse load ever being suddenly applied to the pipe, as already explained in the previous article, the transverse load coming from the expansion by heat of other pipes attached to it. With the notation indicated in Fig. 1, it is to be understood from the laws governing the deflection of beams that if m be the bending moment about any section at a distance, q, from the point of support, which is taken as the origin, that $m = W\,(l - q)$ and $m_{max} = W\,l$. Also $X = \dfrac{m\,d}{2\,I}$, where X represents the stress in the outside fiber; d the depth or outside diameter of the section if it be round, the section being symmetrical about a horizontal line through the center of gravity; and I the moment of inertia of the section.

Further, by the same laws, the deflections of a beam supported at one end and loaded at the other are

$$S = \frac{W}{E\,I}\left(\frac{l\,q^2}{2} - \frac{q^3}{6}\right)$$

$$\text{and } S_{max} = \frac{W\,l^3}{3\,E\,I},$$

E being the modulus of elasticity. From these equations it is evident that

$$S_{max} = \frac{2\,X\,l^2}{3\,d\,E}.$$

When a branch pipe is attached to a boiler nozzle, the boiler furnishes the support, and the support is a rigid one. Whatever load comes on the pipe in a transverse direction comes from the other end. This other end is fixed as regards its direction, so that it can move only in translation, and its axis at the point where it joins the main pipe is always parallel to its original and unloaded direction. So the branch bends in the form of a reverse curve, as shown exaggeratedly in Fig. 2, and this case is clearly not the case of a beam supported at one end and loaded at the other. There is a shearing force throughout the length of the pipe, and inasmuch as there are no external forces acting on the pipe between the two ends, the shearing force is constant. In the case of any beam, the first differential coefficient of the bending moment, in respect to the distance of the section under consideration from the origin, is equal to the shearing force at the section. Since this shearing force is constant, it is evident that the bending moment will be directly proportional to the distance, q, from the origin. Expressed algebraically this becomes

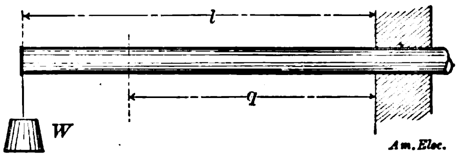


FIG. 1.—BEAM LOADED AT ONE END.

$$\frac{d\,m}{d\,q} = F,$$

where F is the shearing force, and by a single integration $m = F\,q + c$; c being a constant. If the pipe bends as shown in Fig. 2, the fibers at the left-hand end are in tension on top and in compression on the bottom, while at the right-hand end the reverse is the case. There is, therefore, a point of flexure where the fibers are in neither tension nor in compression, and where, consequently, the bending moment is zero. Inasmuch as the two ends are loaded precisely alike, and there are no external forces, the two arms of the curve are of equal length, and the point of flexure is at the center of the whole length.

The equation, $m = F\,q + c$, is true for any beam supported at one end and loaded at the other, and in this reverse curve there are clearly two cantilever beams with a single load at the end of each beam and the deflection is just twice what it would be for a single beam having a length one-half as great as the whole length of the pipe. The deflection, S, of the half length, Fig. 2, is then expressed in the equation:

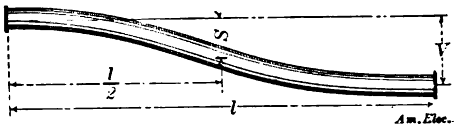


FIG. 2.—PIPE UNDER TRANSVERSE LOAD.

$$S = \frac{2\,X\left(\frac{l}{2}\right)^2}{3\,E\,d}$$

and the total deflection, or the amount which the main pipe can move, is:

$$2\,S = \frac{4\,X\left(\frac{l}{2}\right)^2}{3\,E\,d}.$$

Calling the total deflection $2\,S = V$, and reducing the numerator, the formula becomes:

$$V = \frac{X\,l^2}{3\,E\,d}.$$

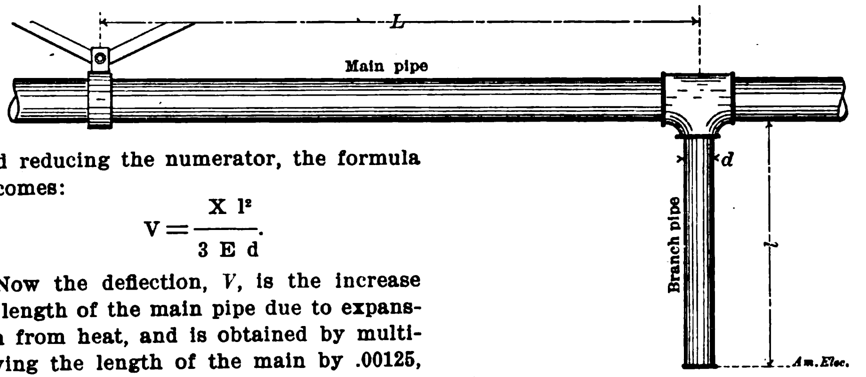


FIG. 3.—MAIN AND BRANCH PIPES.

Now the deflection, V, is the increase in length of the main pipe due to expansion from heat, and is obtained by multiplying the length of the main by .00125, so if $L =$ the length of the main pipe the deflection is $.00125\,L = V$. Eliminating V from the two equations the expression becomes:

$$L = \frac{X\,l^2}{0.00375\,E\,d},$$

and since E is equal to 28,000,000,

$$L = 0.000009524\,\frac{X\,l^2}{d};$$

this last equation is true for the conditions shown in Fig. 3, X being the maximum stress coming from transverse loads in the most strained fiber of the branch pipe.

It is clear that this formula does not take account of the effect of expansion of the branch upon the main pipe, and does not allow for any weakening of the pipe at the joints by cutting away of stock such as would occur in a threaded joint. But there are methods of making joints which do not weaken the pipe at the joints, and the effect of the expansion of the main upon the branch pipe is much greater, in the case at hand at least, than the effect of expansion of the branch upon the main pipe. This question will be discussed, however, in a subsequent article. The case most frequently met with is the one where the main must be of a given length from the conditions of the plant, and the problem to be solved is how short the branches can be safely made, or with the length of the branch assumed, how long may the main be without making some provision for expansion. The formula answers these questions, as it expresses a relation between length of branch and length of main.

The values X and d come from the pipe itself; d is the outside diameter and X the safe stress in transverse. This latter quantity is not the same for all sizes of pipe, for the stress in the pipe, due to steam pressure, must be allowed for, and must be deducted from 16,000 lbs. per square inch, to give the working outside fiber stress. The first step then is to calculate the horizontal stress due to steam pressure, and this pressure will be taken as 150 lbs. unless otherwise noted. The stress is found by multiplying the internal area of the pipe by the steam pressure and dividing the product by the transverse area of the metal; that is, the difference between the outside and inside areas of the pipe. In the case of 8-in. pipe of full standard weight, this stress from steam pressure in a direction parallel with the axis of the pipe is 895 lbs. per square inch, leaving 15,105 lbs. as the safe outside fiber stress tending to bend the pipe, and in the case of 8-in. standard weight pipe, this is the value of X. So in the formula,

$$L = .000009524\,\frac{X\,l^2}{d},$$

X becomes 15,105, and as d is 8.62, the formula reduces to:

$$L = .01669\,l^2$$

for 8-in. standard weight pipe.

Here then is a relation between length of main and of branch, the measurement being in inches, and if the branch be 100 ins. long the main should not be over 167 ins. or 13 ft. 11 ins. long from the anchorage to the joint of junction of main and branch if the main pipe is erected at a temperature of 63 degrees. It is possible to have a main four times this length, and this is frequently done; that is, the main may be erected at a temperature such that when full pressure is turned on, only one-half the full stress will be brought upon the branches. There is an equal stress of the opposite kind brought on the branches then when they are allowed to become cold; that is, the side of the branch that was in tension will be in compression when the main becomes cold. Then the line may be anchored, not at its end, but at the center of its length, doubling this length of 13 ft. 11 ins. twice, or giving as a total 55 ft. 8 ins. If the main is longer than this, or if the branches are shorter than 100 ins., either the branches will have an outside fiber stress greater than 16,000 lbs., or the nozzle to which the branches are attached must spring, which latter is equivalent to saying that the branches are really longer than 100 ins.

In this equation for 8-in. pipe, $L = .01669\,l^2$, if L is made equal to l, both become equal to 60 ins. Accordingly the main itself should not be less than 60 ins. long, if it is of 8-in. pipe, for if it is it will be overloaded by the expansion of the branch pipe. For instance, suppose l is to be 10 ins. long, L could be only 1.7 ins. long. Here the expansion of the branch pipe would rupture the main if it were 8 ins. in diameter. So it is easy to pass the minimum limit in giving dimensions to such a branch pipe. As l is increased beyond 60 ins., L increases very rapidly, as already shown for a length of 100 ins. If $l = 100$ ins., $L = 668$ ins.

If, for the moment, the variation in the value of X is neglected, which is equivalent to assuming that the stress in the pipe due to steam pressure is constant, and the variation here is not great when compared to 16,000 lbs., it is clear that the coefficient of l^2 varies inversely as d, the diameter of the branch pipe. This approximation is not to be recommended, however, for the calculation is most valuable in the limiting cases, and in those cases precision is most desirable. The stress due to steam pressure varies from 1388 lbs. per square inch in the case of 14-in. pipe to 471 lbs. in the case of 2-in. pipe. This variation is approximately 6 per cent of the total allowable stress. If the corresponding values of X are averaged, and this average result taken into the formula, the equation becomes:

$$L = .0143\,\frac{l^2}{d},$$

$$\text{or } L = \frac{l^2}{7\,d},$$

which will give results within 3 per cent of error for pipe of standard weight and of any outside diameter between 14 ins. and 2 ins., all measurements in inches. The formula has all the faults of an approximation, but it can be remembered and used in the preliminary work.

In bending the branch pipe, it is clear that a load in compression is brought to bear upon the main pipe, and this load will in itself decrease the expansion of the main. This load may be computed from the formulas already given. With the case of the 8-in. pipe, 100 ins. long, the transverse load which this can safely carry when supported as shown in Fig. 2, will be found by combining the first two formulas, giving:

$$W = \frac{2\,X\,I}{\frac{l}{2}\,d} = \frac{4\,X\,I}{l\,d}.$$

Substituting these values, viz., $X = 15{,}105$, $I = 72.02$, $l = 100$ ins., and $d = 8.62$ ins., the value of W becomes 5050 lbs., and if the main pipe were 12 ins. diameter its cross-sectional area of metal would be 14.6 sq. ins., so that the load per square inch would be $5050 \div 14.6 = 346$ lbs. per square inch, which is a quantity too small to be taken account of, if there be only one branch pipe. The total stress in a 12-in. pipe stretching .00125 times its length, that is, the force necessary to keep this pipe of constant length while it is being heated 185° Fahr., would be 35,000 lbs. per square inch, which is beyond the safe load of the pipe, and is over 100 times the load coming on a 12-in. main from a single 8-in. branch. It is possible, however, that a sufficient number of 8-in. branches might be used to produce an appreciable effect. A very long manifold of smaller pipe might have an appreciable influence on the main pipe.

TWO ENGLISH BOILER FEED WATER SOFTENERS.

As is probably well known, the hardness of water is caused principally by the presence of calcium and magnesium salts; the former in the shape of bicarbonate and sulphate, and the latter in the form of bicarbonate. The bicarbonates are fairly soluble; but the carbonates are virtually insoluble. By adding to the water a solution of quicklime, the dissolved bicarbonates of calcium and magnesium are robbed of a portion of their carbonic acid, and are reduced to simple carbonates which appear in the form of very fine insoluble powder, rendering the water turbid. If this water be allowed to stand for any length of time the powder subsides, leaving a clear, and to a considerable degree, softened water.

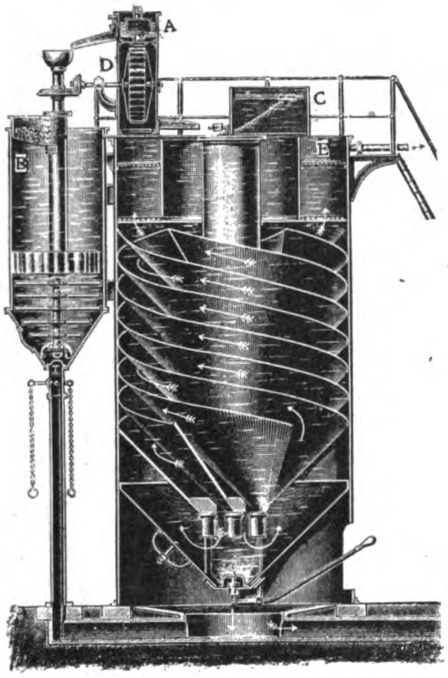


FIG. 1—DESRUMAUX PURIFIER.

The sulphates of calcium and magnesium are removed by the addition of sodium carbonate (washing soda), which forms insoluble carbonates of calcium and magnesium, leaving sodium sulphate in solution.

These processes are usually carried out in large tanks, the purified water being drawn off when the milkiness caused by the carbonates in suspension has subsided. A number of tanks are used, so that the supply may be more or less continuous, several tanks being in various stages of settlement while one is being drawn from. When using tanks, the time of settlement is necessarily protracted, a particle taking some six hours to travel downward through a depth of 3 ft. It is therefore obvious that if this 3 ft. be divided up into a number of different layers, the clearing will take place proportionately faster. This principle forms the basis of the two purifiers herein described. Both are classed as continuous water softeners, and are of foreign manufacture. Fig. 1 shows an English apparatus known as the Desrumaux purifier. It consists of a central vertical tube inside a circular tank. Around this tube are convolutions of sheet metal placed at an angle and a short distance apart, so that water supplied to the top of the central tube and issuing from its bottom must, in its upward course to the overflow, travel around the convolutions. It is stated that by the time the water reaches the top the whole of the matter in suspension is deposited. The apparatus is self-contained, doing its own lime and sodium carbonate mixing, and regulating the amounts of these added to the water to be purified in proportion to the amount of this water. The water enters a small self-regulating tank *A*, with two nozzles, one discharging through a hollow shaft to the bottom of the lime tower *B*, and the other discharging over the water wheel into the mixing tank *D*, which also receives a steady stream of soda solution from a tank *C*. The water passes from the mixer *D* to the bottom of the purifier, and then, passing up and through the filter *E*, is ready to be fed to the boiler.

The apparatus shown by Fig. 2 is the invention of Herr W. Beissel, and is also of English make. As may be seen from the illustrations, the water has a number of alternate paths, all of the same length, instead of a series of convolutions as in the Desrumaux purifier. Fig. 3 represents a cross section of the purifier tank, and Fig. 2 is a general perspective view of the whole apparatus. There is a central tube *a* as in the other system, which rests on a grating *l*, forming the bottom of the main tank. Around the central tube are fixed in an inclined tier a number of funnel-shaped divisions, which are so arranged as to form conical annular spaces of equal size through which the water can circulate. The object aimed at is to have every path for the water of the same length, so that the whole mass of water is equally dealt with and kept in circulation. The deposits of the insoluble carbonates and other foreign matter collect on the inclined surfaces, gradually slip down these, and fall to and through the grating *l*. Care has to be exercised in adjusting the flow of water so as not to exceed the capabilities of the apparatus; but when once adjustment has been made the process of purification is said to be continuous, the water coming away perfectly clear.

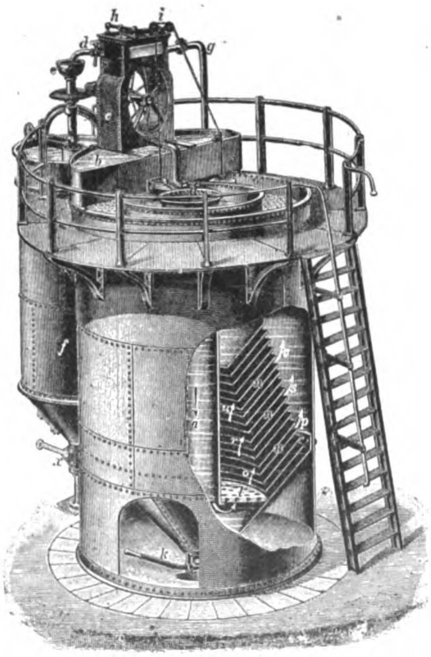


FIG. 2.—BEISSEL PURIFIER.

In Fig. 2 the supply of hard water, or of water which it is desired to purify—for it is claimed that other impurities than the lime and magnesia salts are removed from the water in the course of the process—is delivered through the pipe *g*. The water passes from this pipe to a water-wheel *c*, and also through a cock *d* and pipe *e* to the lime-mixing tank *f*. The main volume of water—that which drives the water-wheel—is then led into the tube *a* by the pipe shown, the amount passing through the pipe *e* being directly proportional to this. The tank *b* holds a solution of carbonate of sodium, and the arrangements indicated by *h* and *i*, which are worked by floats, automatically determine the amount of chemicals which are to be added to the water—the amount being accurately regulated in direct proportion to the amount of water flowing. If the water is cut off, then the supply of chemicals is cut off also.

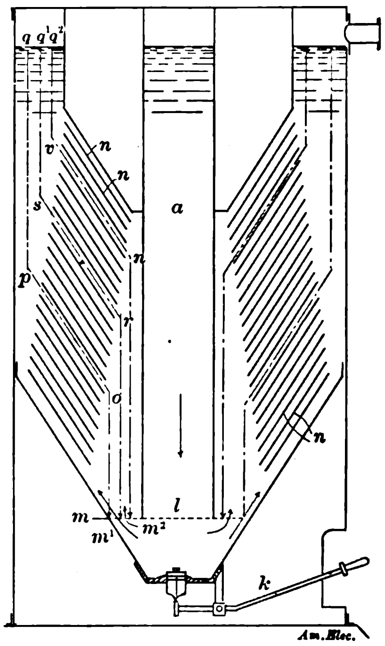


FIG. 3.—CROSS SECTION OF A BEISSEL PURIFIER.

The lime mixture is made by means of the stirrer worked through the bevel gearing by the water-wheel, and it flows from the top of *f* into the tube *a*. The cocks *x* and *k* are for removing sludge from the lime mixer and water purifier respectively. The action of the apparatus is simple. Enough lime is put into *f* to insure a solution of proper strength. The soda tank *b* is filled up to a certain mark with water, and a given quantity of the salt added. The cocks *k* and *x* are opened for a short time to let out the sludge formed during former operations, and all is ready for further work. The water is then turned on through the water-wheel, and the apparatus works automatically till the soda tank is emptied. It is stated that the replenishment of this tank and of the lime mixture, together with the flushing out of the sludge, constitute the only attention which the apparatus requires, and that for considerable periods it may be left to itself.

Abstracts from Foreign Contemporaries

A Regenerative Accumulator.—This apparatus, described in the London "Engineering," is intended to allow in a turbine or any other similar motor the use of exhaust steam from machines having intermittent action. It serves the purpose of a reservoir; the solid and liquid materials which it contains forming a storage in which the steam gathers and condenses when arriving in excess, and subsequently re-evaporates during the period when the main engine slackens or stops. The pressure rises while the apparatus is filling and falls while it is being emptied. The apparatus consists, as may be seen from Fig. 1, herewith, of cast-iron annular basins placed one above the other, inside a cylindrical vessel of sheet iron. The steam, which enters the vessel by the pipe near the top, reaches the basins by the central channel. The portion which is not condensed, as well as that which is re-evaporated, descends along the lateral partitions of the vessel, and reaches the pipe *C*, leading to the low-pressure machine. The water carried away by the steam separates out in the upper chamber, and falls, first through holes in the top plate, thence from basin to basin by the passages in the overflow to the bottom of the vessel, whence it is discharged by the small pipe and an automatic steam-trap. The basins are always thus covered with water. The apparatus is completed with a safety-valve and an automatic steam-valve, for assisting the turbine by steam direct from the boilers. By means of this accumulator it is said to be possible to obtain, in an ordinary-sized hoisting engine plant, an additional motive power of about 500 horse-power, with no expense but the cost of installing the turbine and accumulator, and their maintenance.

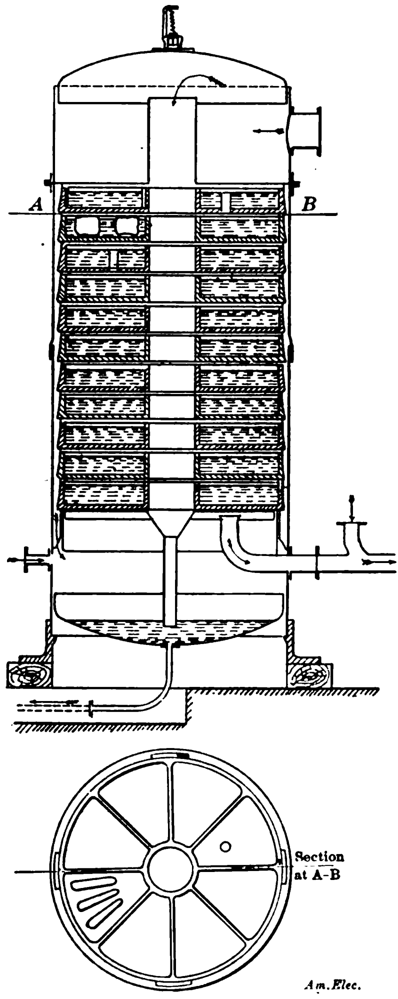


FIG. 1.—REGENERATIVE ACCUMULATOR.

Voltage Drop in Transformers.—The following method, described by O. S. Bragstad in the "Elektrotechnische Zeitschrift," can be used for measuring directly the drop in a transformer in which the ratio of primary to secondary turns may have any value. It is, however, necessary to have another transformer having the same ratio of primary to secondary turns to carry on the test. The connections are shown in Fig. 2, where *I* is the loaded transformer and *I I* the unloaded transformer; *J* is an ammeter; *W*, a wattmeter; *E*, a voltmeter, and 1, 2, 3 a switch. By throwing the switch on the contacts, 1, 1, the secondary voltage at the terminals and secondary power are obtained; contacts 2, 2 give the primary voltage reduced to the secondary, and 3, 3 give the drop and effective loss of power. These measurements are made with constant secondary voltage and current; the secondary phase difference varying. The current supply is connected in this case to the terminals K_1, and the load to the terminals K_2. To measure the voltage drop at constant primary voltage for varying phase difference, the terminals K_1 and K_2 are transposed.

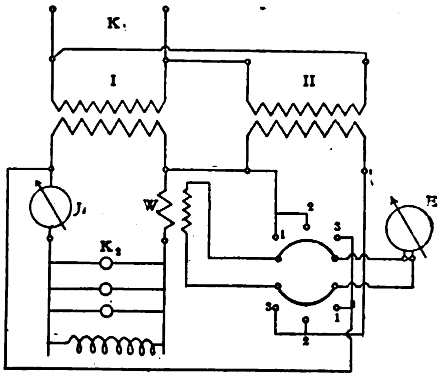


FIG. 2.—MEASURING DROP IN TRANSFORMERS

Duplicate Feeders.—In a recent issue of the London "Electrician," L. Andrews describes a system of duplicate feeders devised by him for the purpose of preventing an interruption to the supply in the event of a short circuit occurring on any feeder. The feeders are connected up as shown by Fig. 3. The sub-station transformers T_1, T_2, etc., are supplied from two independent high-tension bus bars, B_1 and B_2, half of the transformers being on one bar and half on the other. The busses are fed from a common source of supply *G* by means of duplicate feeders A_1 and A_2. High-tension fuses F_1 and F_2 are inserted in series with these feeders, and high-tension fuses H_1, H_2, etc., are connected in series between the primary winding of each transformer and its bus-bar. The interconnecting fuses C_1 and C_2 are provided for connecting the two high-tension busses in parallel. Reverse-current cut-outs R_1, R_2, etc., are inserted between the secondaries of each transformer and the low-tension bus-bars. A pilot wire *P* connects the sub-station with the voltmeter at the generating station, which thus indicates the voltage across the low-tension busses at the sub-station, and a small auxiliary switch *X* on each of the low-tension cut-outs is connected in series with this pilot wire, the object of this arrangement being to signal to the generating station the opening of any low-tension cut-out. Should a short-circuit occur on one of the duplicate high-tension feeders, the faulty section is immediately and automatically disconnected, and the supply maintained through the remaining feeder. The system is in actual operation at Hastings, England.

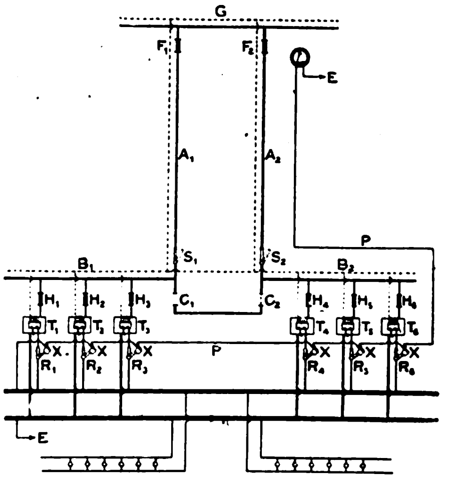


FIG. 3.—SYSTEM OF DUPLICATE FEEDERS.

New Carbon-Zinc Element.—In the regenerable element of Alexis Turnikoff and Count Anatole de Nesselrode, says the "Centralblatt für Accumulatoren," the depolarizer surrounding the carbon consists of a mixture of one part of graphite and two parts of permanganate, soaked in a mixture consisting of a saturated solution of potassium chlorate, and a 50 per cent solution of formic or other aldehyde, the latter preventing the liberation of free chlorine. The excitant is a solution of sal-ammoniac which becomes enriched by a zinc salt. The zinc electrode is formed in thin laminæ. The e.m.f. varies somewhat with the strength of the formaldehyde, being 1.4 volts when this is 50 per cent. The intensity is said to be equal to that of a Bunsen cell. The internal resistance is small and fairly constant, and no action takes place on open circuit.

A Peculiar Street Lighting System — Josef Löwy describes, in a recent issue of the "Zeitschrift für Elektrotechnik," a peculiar system of street arc lighting devised by Czeczowiczka, in which all of the lamps are burned during the first half of the night, and only a part of them during the second half. As shown by Fig. 4, all of the lamps are in parallel and fed by the same mains; *G G* are the lamps which burn all night, and *H H H* are the lamps which burn only during the first half of the night. Each or a group of the latter is in series with a choking coil *D* of negligible resistance and high reactance. During the first half of the night the lamps are fed with direct current, and the choking coils having very little influence, all of the lamps are lighted; but at midnight the supply is changed to alternating current, and the lamps in series with the choking coils receive only a very small current and are extinguished. When properly designed, the author shows that the loss in the choking coils is very small. It is needless to say that the arc lamps must be suitable for both direct and alternating currents. The author does not state how the duplex system of generation is justified commercially, nor what reason there is for crudely complicating the translating devices in preference to running one additional circuit wire to all the half-night lamps.

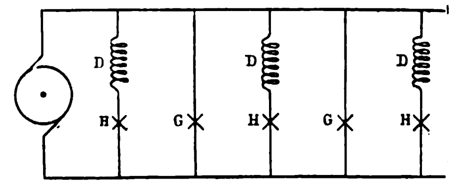


FIG. 4.- STREET LIGHTING SYSTEM.

Prevention of Hard Scale in Boilers.— In a note published in "La Mercure Scientifique," M. Marcel Guèdras remarks that petroleum should never be used as a disincrustant in boilers already covered with scale if they are externally fired; but with internally fired boilers there is no danger. Petroleum added to the feed water forms an emulsion inside the boiler which prevents the lime from agglomerating, so that it does not form a hard scale on the plates; but merely a soft mud, which can be readily washed out. If scale already exists, the petroleum will penetrate the pores of the mass and reach the plate. Under the action of continued heating the lighter portions volatilize, and the decomposition of the heavier portions swells and detaches the scale from the plates. The carbonaceous deposit thus formed may, however, give rise to overheating in an externally fired boiler, as in such a case it tends to rest on the hottest plates.

Steam Engine Governor.—Fig. 5 shows a Whitehead steam engine governor recently described in the London "Engineer." Its construction will be readily seen from the engraving. The balls *A* and their bell cranks are mounted on and driven by a yoke or cross bar *B*. The top of the driving spindle *C* is formed into a cylinder *D*, in which a piston *E* works. The piston rod is hollow and passes through the cylinder cover, being provided at its upper end with nuts which determine the position of the plate *F*. The cylinder is filled with oil, which is allowed to flow from one side of the piston to the other through the passage *e*; the rate of flow, and hence the retardation of the piston, being determined by the position of the spindle *G*, which is adjusted by a set screw against which the spindle is constantly pressed by a small spring *g*. The governor is provided with two springs; one of these, *H*, is compressed between the sliding collar *J* and the plate *F*, while the other, *K*, comes between the piston and the cover of the cylinder. If the piston be free to move, and the oil can freely travel, these two springs when at rest will have the same degree of compression and be in equilibrium. The two springs are proportioned with the idea of making the combined resistance exactly balance the centrifugal force of the balls in all positions. This combination would necessarily cause the governor to hunt, but the introduction of the oil dash pot obviates this. The inside spring is not able to move as fast as the outside spring, because the oil takes an appreciable time to get through the passages in the piston. It therefore follows up the action of the outside spring gradually and is compressed until the total pressure is balanced between the two springs. The outside spring, during the latter part of the movement, is relieved and allowed to again expand a little, till both are equally compressed. It is so arranged that this equal distribution of pressure between the two springs only occurs when the engine speed comes back to normal, the balls assuming a certain new position, and remaining in it till a further change from the normal speed takes place.

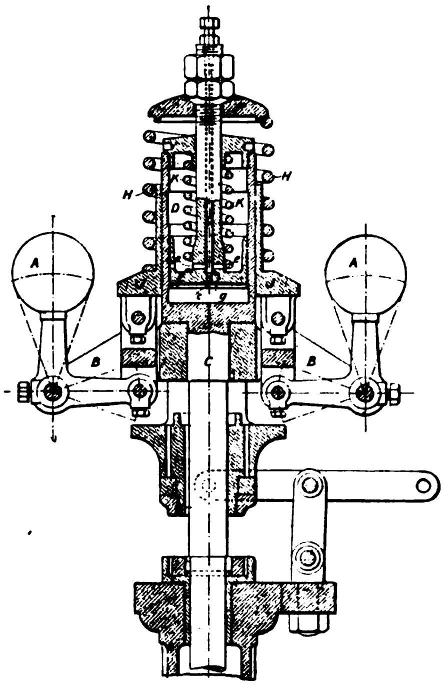


FIG. 5.—WHITEHEAD GOVERNOR.

The "Max" Accumulator Cell.—A recent issue of "L'Industrie Electrique" contains an interesting description of the "Max" secondary cell, which is peculiar in that it has cylindrical electrodes built up of the usual lead paste upon a core of hard lead. The cylinder is finally enveloped in a casing of asbestos thread, to guard against short circuits and loss from crumbling. In Fig. 6 *A* represents the hard lead core, *B* the core covered with the lead paste, and *C* the finished electrode covered with its envelope of asbestos. These electrodes are manufactured in two sizes, 3.12 and 8.58 ins. long respectively; but can be made in almost any length. The plates *D*, *E'*, and *E* are of hard lead and are used to secure the cylindrical electrodes in groups, as indicated at the left of the engraving. Fig. 7 shows a finished set of electrodes ready for immersion in the electrolyte, the two broad plates of hard lead being used as current connections for the positive and negative groups respectively. The special advantages obtained by this form of accumulator are said to be high capacity in proportion to gross weight, and durability resulting from the special form of the electrodes. The manufacture of the cylindrical electrodes is carried out by means of a specially designed machine, which covers the hard lead cores with the lead paste and cuts off the electrode to the required length in

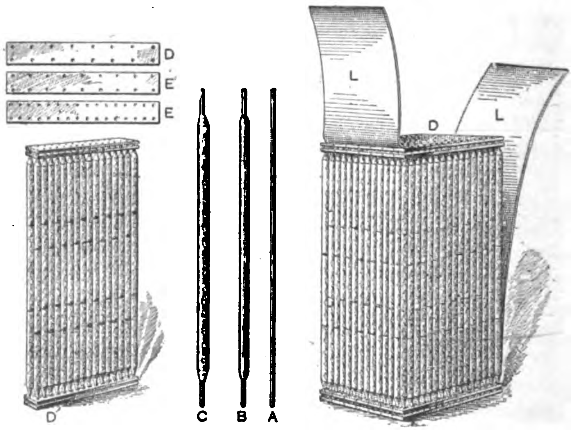


FIG. 6.—MAX ACCUMULATOR CELL.—FIG. 7.

one operation. Great pressure is used in fixing the lead paste on the core, and the envelope of asbestos thread is spun on the electrodes after drying, this operation being performed by a specially designed machine.

Hot-Wire Wattmeter.—"L'Industrie Electrique" describes an interesting and extremely simple hot-wire wattmeter for direct and alternating currents, in which two hot wires, *a* and *b*, are arranged in combination with two additional resistances, *c* and *s*, as shown in Fig. 8. On the supposition that the elongation of a hot wire is proportional to the heat developed in it, the difference of the elongation of the two hot wires, *a* and *b*, is proportional to the product of the e.m.f. *U*, the current *I*, and the cosine of the phase difference between *U* and *I*; or, in other words, the difference in elongation is a measure of the real power. The device by which the needle of the instrument is made to give deflection proportional to the difference of the elongation of the two hot wires is very simple, and is shown in Fig. 9. The hot wires, *a* and *b*, are fixed at one end to the lever, *F*, which is acted upon by a spring. The other ends of the wires are connected to a piece, *L*, pivoted at its center. For slight elongation the deflection of *L* is proportional to the difference of the elongations of *a* and *b*, and hence proportional to the power measured.

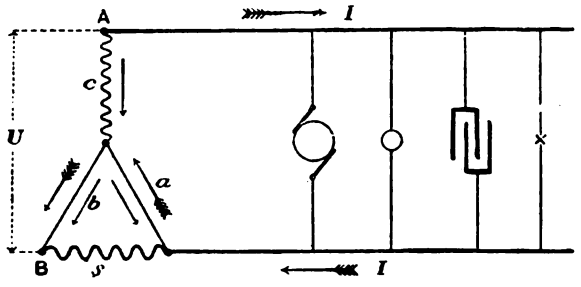


FIG. 8.—HOT-WIRE WATTMETER CONNECTIONS.

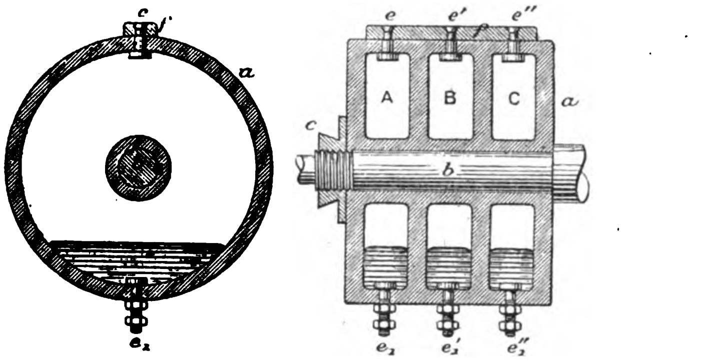


FIG. 10.—STARTER FOR THREE-PHASE INDUCTION MOTORS.

Starting Three-Phase Induction Motors.—"L'Industrie Electrique" describes a device of a French company for starting three-phase induction motors; a resistance being in the secondary circuit when the motor is started, and being automatically cut out when the motor has attained a certain speed. The device is shown by Fig. 10. A cylinder, *a*, of insulating material is mounted on the axle, *b*, of the secondary of the induction motor and revolves with it. This cylinder is divided into three parts, *A. B. C*, insulated from one another. In the walls of each of these three parts there are two metallic screws at two diametrically opposite points, *e* and e_1, *e'* and e'_1, *e''* and e_1''. The three screws, *e*, *e'* and *e''* are connected together by the metallic rod *f*; on the other hand, the other three screws, e_1, e'_1, e_1'', are insulated from one another and are connected to the three points in which the star connected armature windings of the motor are connected with starting resistances, placed in the armature. It is evident that as long as the three screws, e_1, e'_2, e_1'', are insulated from another, the starting resistance is inserted in the armature, but when these three screws are connected together by a conductor, it has the same effect as if the starting resistances were cut out. For this purpose a certain amount of mercury is placed in the drum. When the motor starts and runs up to full speed, the mercury is revolved, and, on account of the centrifugal force, finally forms itself into a ring, so that it covers the whole of the walls of the three compartments. The screws, e_1, e'_1, e_1'', are thus connected through the mercury to the three screws, *e*, *e'*, *e''*, and as the latter are connected together by the conducting rod, *f*, the former three screws are short circuited. By adjusting the amount of the mercury, the moment at which the starting resistance becomes inactive may be varied.

Some Recent Electrical Patents

Line Wire Insulator.—When electric light or power wires are suspended from insulators beneath the cross-arm, extra precautions are necessary in order to prevent the establishment of a leakage path during wet weather, on account of the facility with which moisture is enabled to travel from the cross-arm to the wire when the relative positions are as specified. With a view to reducing the possibility of leakage to a minimum, Ralph G. Hemingray provides a composite insulator of the form shown by Fig. 1, which shows an elevation and a cross-section in the vertical plane. The line wire is secured to the knob, *B*, being held in the under groove by means of a tie wire in the annular groove just above it. The knob, *B*, is screwed on the end of a shank or pin, *C*, which may be of any material but is preferably of wood, and which in turn is screwed into the body of a protecting bell, *A*, of insulating material. This bell is of the familiar multi-petticoat type, and is to be secured to the cross-arm by some means not described by the inventor. Patent No. 686,609.

Regulating Device for Series Alternating-Current Arc-Lamp Circuits.—The principle and application of automatic reactive or choking coils for maintaining a constant current in a series circuit supplied from a constant-potential source have become so well known in the art that a discussion of them is not necessary to an understanding of the patents recently issued to Malcolm H. Baker for this method of regulating arc-lamp circuits, and also covering the means whereby such regulation is secured. A number of patents has been issued to Mr. Baker relating to this class of device, from which the illustrations shown by Figs. 2 and 3 have been selected as typical. Fig. 2 illustrates the

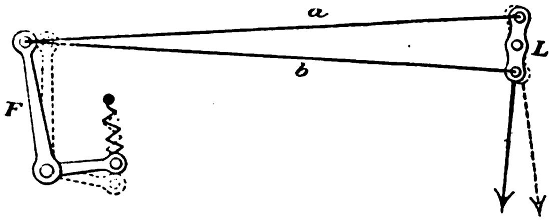


FIG. 9.—WATTMETER NEEDLE CONNECTIONS.

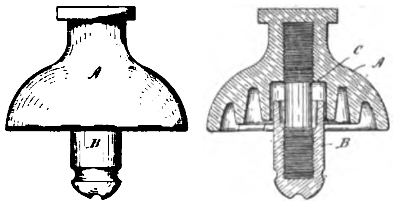


FIG. 1.—LINE WIRE INSULATOR.

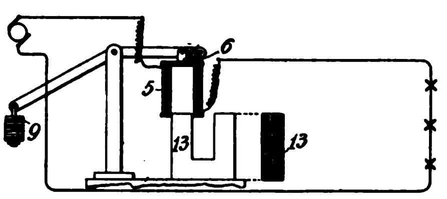


FIG. 2.—CIRCUIT REGULATOR.

principle of construction employed in the regulator. A solenoid, 5, is hung from the end of a bent lever in such position as to embrace the end of a laminated core, 13, so that a current passing through the coil will cause it to be drawn downward over the core to a greater or less extent, depending upon the strength of the current. The bent form of lever is used in order to increase the counter-balancing effect of the weight, 9, as the coil is drawn down over the laminated core, so that a slight increase in current in the coil will not pull it down the entire length of its travel, but will only draw it down until the increasing pull of the weight balances the magnetic pull of the solenoid on the core. Fig. 3 illustrates the application of this form of regulator to an individual arc lamp, the lever and counter-balancing weight being omitted in the drawing. The patents also cover multiple forms of the regulator, in which several coils are arranged to embrace the several legs of a single core, each coil being in series with an individual circuit. The master patent covers the method of maintaining constant current in a series alternating-current circuit by means of a reactance device having a stationary and a movable part, one of which is a winding connected in series with the circuit and so arranged that its magnetic pull on a core is opposed by a mechanical force so correlated to the magnetic force that upon a change of resistance in the circuit it will bring the moving part of the reactance device to equilibrium at such a point as to produce the proper choking effect for maintaining constant current. Patents No. 684,165 to 684,169, inclusive, and 684,340 to 684,342, inclusive.

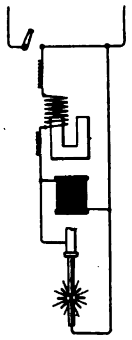


FIG. 3.

Automatic Lighting System for Telephone Booths.—Where an attempt is made to provide an automatic system for telephone booths which shall cause a lamp to be lighted while the booth is occupied and extinguished when it is vacant, the means usually resorted to consists of some form of switch actuated by the opening and closing of the booth door, the lamp circuit being closed when the door is tightly shut and open in all other positions of the door. This is subject to the obvious disadvantage that special manipulation of the door is necessary in extremely warm weather, when it would be practically impossible for one to remain in a booth for any length of time with the door tightly closed, and that on the other hand the accidental closing of the door when the booth is vacant will defeat the object of the arrangement. With a view to attaining the desired result by perfectly natural movements on the part of the telephone user, Frederick E. Lister has devised and patented the arrangement shown by Fig. 4. This arrangement consists of two simple contact-closing devices, both of which are normally held open, the one by the weight of the telephone directory, and the other by the weight of the telephone receiver. When a person enters the booth to use the telephone, if the desired subscriber's number is unknown the natural procedure is to take up the directory in order to ascertain the number. This action relieves a contact-closing spring from the weight of the book and the spring automatically lights the lamp. The number being ascertained, the book is released and its weight opens the circuit. The object in arranging the telephone receiver hook so that it will close the lamp circuit when the receiver is removed from the hook is to facilitate the use of a slot pay station, as well as to enable the user to take notes if desired during the conversation. It is obvious that as long as the book and receiver are both out of use the lamp will remain unlighted. Patent No. 684,274.

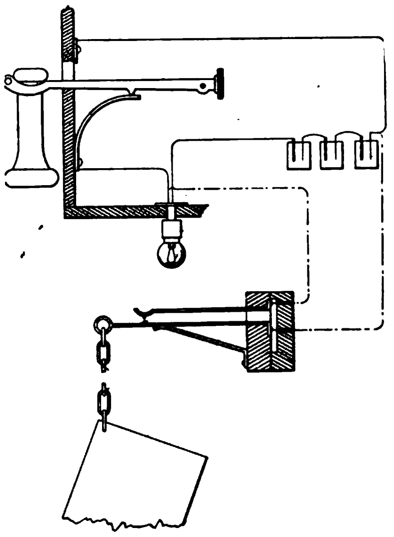


FIG. 4.—LIGHTING SYSTEM FOR TELEPHONE BOOTHS.

Motor-Starting and Speed Regulating Device.—The ordinary starting-box required for bringing a direct-current motor up to speed has constituted an objection to this type of machine as compared with an alternating-current motor, and in places where explosives are manufactured, or where the air is normally filled with explosive dust, the direct-current starting-box is practically barred. Several attempts have been made to substitute for the conventional type of motor starter some form which will not be open to the objections which apply to that form, among them being an adaptation of the fly-ball governor, which has been patented by Christian W. Kragh, and which is illustrated diagrammatically by Fig. 5. This arrangement is a combined motor starter and speed regulator. The motor is provided with a shunt winding, *C*, and a differential series winding, *A K*. When the armature is at rest, that portion of the series winding, *A*, is in series with the brushes and prevents an abnormal rush of current through the machine, as well as giving a heavy starting torque, this winding being connected so as to magnetize the poles in the proper direction for running. At normal speed the governor balls bring the sliding contact to the middle position, cutting out the series winding entirely. Should the load be reduced to such an extent as to cause the motor to speed up, the governor balls will be carried further out and cut in more or less of the winding, *K*, which opposes the shunt winding, *C*, and thus reduces the armature torque and checks the tendency to speed up. Should the speed fall below normal, the governor cuts in more or less of the assisting winding, *A*, increasing the armature torque. In the event of excessive speed from any cause, such as the opening of the shunt circuit while the motor is running without load, the governor balls are thrown to the extreme position indicated by the dotted lines, in which position they are held by means of a spring latch, the detail of which is shown at the bottom of the engraving. When the balls are in this extreme position the sliding contact finger is carried entirely beyond the stationary contacts, thus opening the armature circuit. The patent does not cover simply the use of a fly-ball governor for the purpose of cutting in and out windings or resistance coils in series with the armature, this device being old and well known in the art; it covers, however, the use of the fly-ball governor or its equivalent for cutting in and out sections of a resistance in series with the armature, combined with the locking device for holding the governor balls in the open-circuit position in case of excessive speed. The patent also covers the use of differential series windings on the field magnet, sections of which are cut in and out according to the requirements of the conditions by means of "an automatic controlling device responsive to the speed of the armature." Patent No. 685,852.

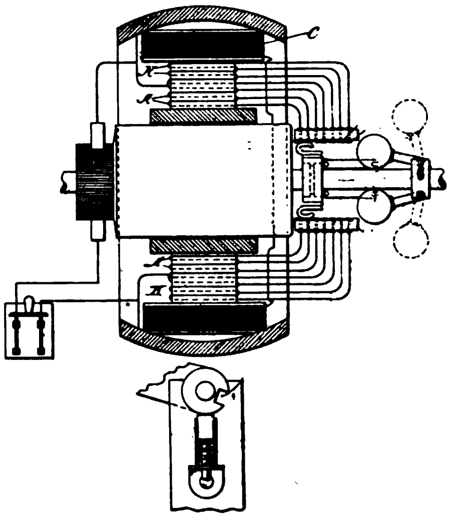


FIG 5.—MOTOR STARTING AND SPEED REGULATING DEVICE.

Telephone Call Recorder.—One of the disadvantages of most forms of automatic recording apparatus, the function of which is to register telephone service rendered a subscriber whose service is paid for according to the number of messages transmitted, is that the apparatus does not discriminate between efforts to use the telephone which fail for one reason or another, and calls of the character for which payment is actually intended to be made. A simple device and arrangement of circuits has been patented by Frank R. McBerty, in which this disadvantage is obviated. Fig. 6, herewith, illustrates the application of this arrangement to a central-energy lamp-signal exchange system. In the diagram, *a* represents a polarized registering mechanism consisting of a train of gear wheels and an escapement, the latter being actuated by the armature of a polarized electromagnet. The windings of the magnet are connected in series with the cut-off relay, *c*, between the test ring of the switchboard jack and the ground. The recording device is so arranged that a complete oscillation of the armature from one side to the other and back again advances the indicating hand on the dial of the recorder one figure. Therefore, two impulses of current through the magnet winding, one in one direction and the other in the reverse direction, are necessary in order to record one call or message. Referring to the cord circuit, the left-hand plug is the answering plug, and the right-hand plug is the calling plug. The front contact of that supervisory relay, the winding of which is connected between the sleeve of the answering plug and the main battery, is connected through a resistance to the negative terminal of the supervisory lamp battery, *i*, the positive terminal of which is grounded. The supervisory relay in circuit between the sleeve of the calling plug and the main battery is provided with an auxiliary winding, one terminal of which leads to the front contact of the relay armature and the other terminal to the positive end of an auxiliary battery or other source of current, the negative end of which is grounded. When the answering plug (the left-hand one in the diagram) is inserted in the spring jack, the negative terminal of the battery, *i*, is connected to the left-hand recording device and an impulse in one direction is given. When the connecting plug (the right-hand one in the diagram) is inserted in the spring jack of the called subscriber, no change is made in the condition of the recording device until the called subscriber removes his receiver from the hook and thus closes the circuit of the main battery, which then energizes the right-hand supervisory relay, drawing its armature against the front stop; this obviously disconnects the battery, *i*, from the recording device and puts the latter in connection with the positive terminal of the auxiliary battery shown at the right of the supervisory lamp, giving the necessary reverse impulse through the recording device to move its pointer one notch. The auxiliary winding on the right-hand supervisory relay will obviously hold up the armature as long as the left-hand or answering plug at the exchange is in the calling subscriber's spring jack; withdrawing this plug opens the circuit of the supervisory relay, of course, and the conditions are restored as shown in the diagram. When a connection is made with the spring jack of any line in completing a connection ordered, or from some other line, the recording device is not operated, because only a negative impulse passes through it. Patent No. 60,880.

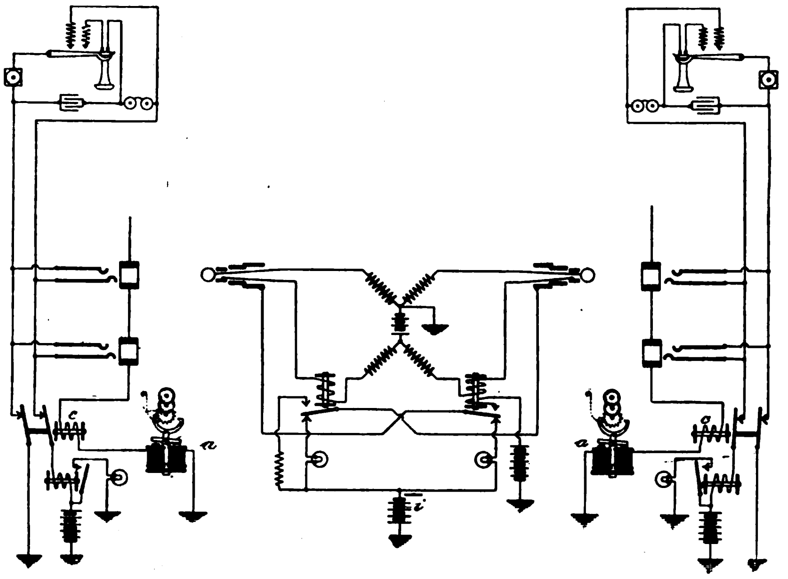


FIG. 6.—TELEPHONE CALL RECORDER.

GERMAN CENTRAL STATIONS.

The German papers of recent date publish some very interesting statistics of German central stations as of the date of March, 1901. It is to be regretted that 150 plants—almost a quarter of the number of works which were in existence in 1900—had not returned the inquiry sheets and were consequently omitted from the lists. The report of "capital invested" was an innovation, and the data are incomplete. Only 318 out of 786, the total number of central stations, have answered this inquiry. These 318 works, of 137,508 kilowatts power, have cost 223,756,481 marks ($53,254,042). On an average, therefore, the kilowatt requires an investment of 1628 marks ($387.36); and assuming this average for the total of power available, 290,000 kilowatts, the total capital investment in central stations is 472 million marks ($112,336,000). Another basis of estimate gives 540 million marks ($128,520,000); neither figure is reliable, but they give a rough idea of the capital invested in these plants.

The thirty-three German towns with more than 100,000 inhabitants all possess at least one public electric station (Kiel excepted); most medium-sized towns are also provided, but there is enough scope left for enterprise. The 768 electric stations of 1901 represent an increase of 122, or considering that 26 works have been removed from last year's list, of 148 works over 1900; 90 works are under construction. Altogether 1200 places are supplied with electric light or power; one plant furnishes 66 places within a radius of 12 miles; 81.3 per cent of all central stations, representing in their engines 43.8 per cent, and in their engines and batteries 49 per cent of the total power, supply exclusively direct current. The power percentages of last year were higher, 47.4 and 53.8 respectively. The reason is that the numerous small plants are generally on the pure direct-current system, but not the recent large additions. There are 43 mixed three-phase and direct-current plants aggregating 86,985 kilowatts in engine and 102,511 kilowatts in engine and battery power. Of combined alternating and direct-current systems there are 10, together of 6874 kilowatts; their battery power amounts to 105 kilowatts. The purely triphase plants number 45, with 41,634 kilowatts power; the mono or biphase plants number 44, with 17,548 kilowatts. Monocyclic generators are employed in two plants together of 950 kilowatts.

Only 3.8 per cent of the strictly direct-current plants operate without accumulators. The accumulators represent 36.2 of the engine power, and 26.6 per cent of the total power of these direct-current plants, and the accumulators of lighting stations in general make up 21.6 of their engine power, and 17.7 of their combined power. As regards primary power 60.3 per cent of all central stations, representing 80.7 per cent of the total power available, rely entirely on steam.

Water power is not of general importance in Germany; besides Rheinfelden, with its 123,369 kilowatts, there are 72 small water-power plants, aggregating only 3354 kilowatts. Both steam and water power—one, as a rule, as reserve—are employed in 170 works of 35,969 kilowatts. Gas power (including furnace and producer gas) is now solely relied upon in 39 central stations of 3106 kilowatts. Gas engines are, further, to be found in many works; but their total power does not make up more than 1.1 per cent of the total engine power of all the central stations.

The 38 electrical central stations of the large towns and of the Silesian mining districts of Chorzow and Zaborze, ranging from 22,075 kilowatts (Oberspree, near Berlin) down to 2072 kilowatts (Hanover) are with their 192,055 kilowatts more powerful than the other 730 works put together. There are connected to the 768 works, 3,403,205 incandescent lamps, averaged at 50 watts, 64,278 10-ampere arc lamps, and 141,414 motors, not reckoning current for electrolysis, heating, etc. The respective increases over last year represent 17.8, 29.7, 28.4 and 33 per cent. The central stations use 126,695 electric meters. The 768 electric stations mentioned are located in 749 different places.

NOTES.

Underwriters' Annual Meeting. — The annual meeting of the electrical committee of the National Board of Fire Underwriters will be held at the New York Board rooms, 32 Nassau Street, beginning at 10 o'clock a. m. on Tuesday, December 3.

Engine Builders' Association.—The Engine Builders' Association of the United States will hold a meeting at Sherry's, New York City, beginning December 2. The convention will be followed by a dinner at the same place, at 8 p. m., December 3.

Honors for Prof. Elihu Thomson. —The Franklin Institute has awarded to Prof. Elihu Thomson the John Scott legacy premium and medal for his invention of the constant-current alternating arc-light transformer. This transformer is now well known as the General Electric floating-coil type of apparatus.

The National Electrical Contractor is the name of a new periodical, the first number of which has just been received. The new journal is a monthly of magazine size and published by the National Electrical Contractors' Association, with headquarters at Utica, N. Y. The first number promises well, and the magazine should find a welcome at the hands of contracting engineers throughout the country.

M'Kinley National Memorial.—We are requested to announce that Col. Allan C. Bakewell, of New York City, has been authorized by the New York State organization to receive subscriptions for the McKinley National Memorial Association, the object of which is to erect at Canton, Ohio, a suitable memorial to the late President. No money should be paid to anyone claiming to represent Col. Bakewell unless such person is provided with satisfactory credentials from him.

A Rugged Generator. —An interesting illustration of the thorough insulation of some modern high-potential electrical machinery was afforded recently when the dam of the municipal plant at Austin, Tex., broke down. The power house was so situated that when the dam broke one of the generators fell a distance of 60 ft. into the river, and was buried under 6 ft. of sand by the tremendous rush of water. This generator was dug out of its resting place in the river bed, washed off with a hose, and allowed to stand for three months, during which time it dried out, and it has been used continuously ever since in a steam plant which the city of Austin has erected. This generator is a three-phase 2500-volt General Electric machine.

Lehigh University Expansion.—There is now in course of erection an addition to Lehigh University consisting of a stone laboratory building 43 x 90 ft., to be used in connection with the steam engineering work of the University course in mechanical engineering. Next fall it is purposed to add to the present curriculum a special and comprehensive course in electro-metallurgy, which, it is said, will be the first one of the kind to be established in this country.

Technique of the Daily Press.—The Berlin correspondent of the London "Standard," in describing the Zossen polyphase railway installation, built for a speed of 125 miles per hour, writes that in order to operate the cars at such high speed "double-faced currents must be chosen." "The cables and conductors in the car," he says, "are made to turn automatically, so that every danger is excluded." Moreover, "a greater number of passengers could be transported on a train of the same length than on one driven by steam, because the motors also accommodate passengers." The latter is an improvement in carrying capacity thus far neglected by designers of railway apparatus in this country.

Electric Lights for the Elevated Stations.—Patrons of the Manhattan Elevated Rail-Railroad lines are rejoicing in the prospect of the completion of the first step in the work of electrically equipping the whole elevated system, the initial step consisting of providing electric lights in the stations and on the station platforms of the roads. The Second Avenue line will be equipped first; each station is to have 50 12-c.p. incandescent lamps. The total number of lamps that will ultimately be used is about 35,000; this includes, of course, the lights in the trains, which will not be put into service until the third-rail track equipment is complete and part of the power house machinery is in operation. Mr. W. E. Baker, electrical engineer of the system, states that the Second Avenue cars will be fully equipped and electrically driven very soon after the first of the year.

The Automobile Show.—The second annual exhibition of motor vehicles was held in New York City under the auspices of the Automobile Club of America during the week ending November 9. The track which encircled the exhibits on the main floor last year and constituted a strongly attractive feature, was omitted this year because the officers of the club felt it unwise to incur the danger from fire due to the use of gasoline and the chances of collision or other accidents due to high speed, which the track obviously entailed. Another feature which was omitted this year was the steep grade on the roof garden, where a fine display of hill climbing was made last year. The absence of these features, however, did not appear to decrease general interest in the show, and a number of sales was reported, some of them of the costliest machines on exhibition. The exhibits were of the usual character and were very attractively arranged.

American Exhibition. — There is to be held at the Crystal Palace, London, from May to September of next year, what is to be known as the American Exhibition, consisting of classified exhibits of American natural and industrial products. The classes are as follows: Class I, Machinery and mechanical industries; Class II, Natural and agricultural products; Class III, Prepared food products; Class IV, Drugs, surgical appliances, etc.; Class V, Vehicles and accessories, furniture and stationery; Class VI, Hygienic, lighting, heating, ventilating and sanitary appliances; Class VII, Textiles; Class VIII, Musical, photographic, and optical instruments and apparatus; Class IX, Education and science; Class X, Naval and military equipment; Class XI, Fine arts. In connection with the exhibition a commercial bureau will be established, whence information may be obtained concerning channels of trade and methods of placing American goods in British and Continental markets. Diplomas and medals of merit will be awarded to exhibitors. More complete particulars may be obtained from Alfred H. Post & Co., Produce Exchange, New York.

Wireless Telegraphy for Belgian Mail Packets. —Early this year the Belgian State Railways administration furnished the steamer "Princess Clementine," one of the Dover-Ostend mail boats, with a wireless telegraph installation. This was done for the purpose of giving the system a trial, with a view to adopting it on all the vessels of the fleet. The installation has already proved of such service as a means of communication with the shore that the administration has decided upon equipping all their vessels with wireless telegraphy apparatus. Some time ago when making the passage between Ostend and Dover, the captain of the "Princess Clementine" observed as he came near the Ruytingen light-ship, that he was being signalled. Communication with the light-ship developed that the lighting apparatus of the Ruytingen had become out of order. The captain of the mail packet immediately dispatched a wireless message, which was received by the Marconi installation at La Panne and thence transmitted to the lighthouse department at Dunkerque. A crew immediately set out for the light-ship and effected the necessary repairs before nightfall. This is but one instance of many in which the wireless installation has proved of immense value.

The National Bureau of Standards.—A site for the new government Bureau of Standards has been selected, and plans for the two buildings which have been authorized will be ready for submission to the board of visitors when it meets at Washington, D. C., this month. The site consists of eight acres of land on the Pierce Mill road just outside the city of Washington, and the buildings are to house a laboratory and generating equipment. The new bureau, which was authorized at the last session of Congress, is already at work in temporary quarters in the Butler Building opposite the Capitol, and is receiving inquiries daily from manufacturers throughout the country concerning the testing of standards and measuring instruments. The bureau is authorized to exercise its function for any scientific society, educational institution, corporation, firm or individual within the United States engaged in any pursuit requiring the use of standards or standard measuring instruments, including electrical standards for the measurement of resistance, electromotive force and current, also electrical power measuring instruments and photometric standards.

The Value of Engineering Journals.—In an address recently read before the students of the Sibley College of Mechanical Engineering, Cornell University, Prof. H. Wade Hibbard gave some sound advice on the importance to college students of a habitual perusal of engineering periodicals, and pointed out the advisability of using a card index for the purpose of enabling a student to readily locate engineering articles at any time subsequent to their publication. Prof. Hibbard said that while books are absolutely necessary, they are by the very necessity of their production always and inevitably behind the times, whereas the student has available in the pages of the representative periodicals the latest developments in the various branches of engineering practice. The reading of articles by famous engineers, only to find them severely criticised afterwards, is good for the confiding student who has perhaps supposed that all engineers and professors are agreed. Ruts and out-of-date ideas in college instruction cannot prevail with a student who reads the engineering papers. Prof. Hibbard called attention to the carelessness of students as indicated by letters to editors of periodicals stating that such and such an article had been read months before, but while the student had recognized its value and intended to make records from it, he had not done so and had lost track of the exact date of the issue and possibly the name of the paper in which the article appeared. The truthfulness of this example will be appreciated by our contemporaries, who doubtless, like ourselves, are constantly receiving just such letters. As a means of obviating this kind of dilemma, Prof. Hibbard recommended the use of a card index in preference to a note book or any other form of record, and outlined his own practice in the maintenance of such an index.

Long Distance Transmission in California.—As we go to press, the Standard Electric Company of California is about to complete its high-tension line to the Eighth Street sub-station in San Francisco. The completion of this line makes available in the city of San Francisco electrical energy developed on the Yuba River and conveyed a distance of 222 miles over the lines of the Bay Counties Power Company and the Standard Electric Company. S. K. C. apparatus is used.

A Grievous Waste of Raw Material.—The *ignis fatuus* of heatless light has led a college professor along weird paths, one of which has terminated at the extraction of faint light rays from a porterhouse steak in a very advanced state of decay. The possibilities of this line of research are appalling. With all the porterhouse steaks cornered by the local lighting companies, life would become a joyless monotony. Those to whom fish and fowl do not appeal would certainly prefer comfortable darkness after sunset rather than illuminated starvation. And there is the harrowing thought of a clothespin applied neatly but firmly to one's nose when Maria brings in the lights after dark. It won't do, professor. Please abandon this investigation, or try a different tack.

Thoroughly Qualified.—Mention has been made several times in our columns of the commendable policy of the Cuyahoga Telephone Company, Cleveland, Ohio, in establishing an information bureau for the benefit of its subscribers, but there is a somewhat humorous phase to this feature of the company's business which has not hitherto been brought out. It goes without saying that a person in charge of such a bureau must be not only gifted with unusual amiability and patience, but must also be thoroughly posted on the current affairs of the day in every conceivable branch. The young lady who has been put in charge of the information bureau not only fulfils these requirements admirably, but has, we are advised, an additional and crowning qualification, namely, the benefit of a long term of experience in educating imbeciles at a state institution!

The Parallel Operation of Alternators.—At a recent meeting of the American Institute of Electrical Engineers a group of extremely interesting papers was read, the subjects of which were so closely akin that all of the papers might easily be dovetailed together to form a single well-rounded discussion of the subject of the parallel operation of alternating-current generators. The first paper was one by President C. P. Steinmetz, on "Regulation in Prime Movers and Successful Operation of Alternators." This was followed by a paper on "Angular Variation in Steam Engines," by P. O. Keilholtz, of Baltimore; one on the "Parallel Operation of Engine-Driven Alternators," by W. L. R. Emmet; one on the "Parallel Running of Alternators," by Ernst J. Berg; and one on the "Angular Velocity in Steam Engines in Relation to Paralleling of Alternators," by Walter I. Slichter. In his paper, Mr. Steinmetz brought out the interesting point that for parallel operation it is necessary that the speed of alternators should drop somewhat under an increase in load. If the governing mechanism is so perfect as to maintain absolutely constant speed at all loads, the division of load becomes indefinite and parallel operation ceases to be feasible. If the drop of speed with increase in load is not uniform and the speed is almost constant under moderate loads, alternators may operate satisfactorily in parallel at full load but see-saw at light load. The tendency to hunting on the part of alternators and synchronous motors, due to periodic variations of angular velocity such as characterize reciprocating prime movers, appears to be aggravated by the use of heavy fly-wheels on the prime mover.

Mr. Emmet, in his paper, referred to the trouble which had been experienced in early attempts at parallel operation, due to the oscillation of the engine governor, and described a device which he had perfected, with the aid of Messrs. H. W. Buck and Harte Cook, which had cured this tendency. This device was described in the article on "Modern Practice in Steam Engine Construction," which appeared in the June, 1901, issue of this paper, and was illustrated by Fig. 27 of that article. The device consists of a peculiarly arranged dash-pot used in conjunction with the engine governor. Mr. Emmet stated that his experience also had indicated that alternators driven by engines having light fly-wheels were easier to parallel than when heavy fly-wheels were used. Mr. Berg's paper gave an analytical discussion of the principles governing the parallel operation of alternators driven by steam engines or turbines. One of the deductions made by Mr. Berg is that differences in armature reaction affect the division of the load between machines running in parallel. A machine having twice as high armature reaction as its mate, when two machines are working together, will take only one-half the load, and so on, the division of the load varying inversely as the ratio between the armature reactions. Mr. Slichter's paper dealt more particularly with the function of the governor of an engine direct-connected to the alternator. One of the points brought out was that the angular velocity of the fly-wheel varies in two different ways due to two different causes, one variation being due to a change in load and the other to irregularities in the force applied to the crank shaft. The title of Mr. Keilholtz's paper was somewhat of a misnomer, being considerably broader than the actual scope of the paper, which consisted of a review of a comprehensive test made on a McIntosh & Seymour engine in order to ascertain the actual angular variation shown by the engine. The paper was extremely interesting.

ESTABLISHED 1889.

American Electrician,

WITH WHICH IS INCORPORATED
Electrical Industries.

CECIL P. POOLE, Editor.
W. H. ONKEN, Jr., Associate Editor.

Published on the first of each month by the
American Electrician Company,
NEW YORK: 120 Liberty Street.
CHICAGO: Monadnock Block.
PHILADELPHIA: 929 Chestnut Street.
LONDON: Hastings House, Norfolk Street, Strand.

JAMES H. MCGRAW, President.
A. E. CLIFFORD, Vice-President.
C. E. WHITTLESEY, Treasurer.
E. E. WOOD, Secretary.

Subscription, - $1.00 Per Year.
In the United States, Canada and Mexico.
FOREIGN COUNTRIES, $2.00.

NOTICE TO SUBSCRIBERS.

Subscribers will find on addressed wrappers of their papers the date on which their subscriptions expire. This will hereafter be the only method of acknowledging the receipt of subscription payments.

In requesting change of address both the old and the new address should be given.

NOTICE TO ADVERTISERS.

Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

Vol. XIII. DECEMBER, 1901. No. 12

The American Electrician has a larger paid subscription list than any other electrical journal in the world.

CONTENTS.

A Model Small Central Station, by C. W. Obert 565
Rotary Converters, by A. S. McAllister... 568
Brick Chimneys for Power Stations, by William D. Ennis, ... 570
On the Use of Zinc in Boilers, by R. A. Douglas, ... 572
An Old Timer, by A. B. Weeks..... 573
A Simple Method of Calibrating a Voltmeter, by J. Rowland Brown..... 573
Transverse Stresses in Steam Pipes, by A. S. Mann..... 574
Two English Boiler Feed Water Softeners 576
Abstracts from Foreign Contemporaries 577
Some Recent Electrical Patents..... 579
German Central Stations..... 581
Notes 582
Editorial 584
Design for a 1-h.p. Gas Engine, by J. C. Brocksmith, M. E..... 586
Calorimetry, by Chas. L. Hubbard..... 591
Telephone Exchange Notes, by W. S. Henry 591
Interior Wiring 592
Some Brush Arc-Light Dynamo Troubles and Their Remedies, by F. B. O'Hanlon 596
The Care of Street-Railway Controllers, by Frank Berry, Jr..... 596
Lessons in Practical Electricity..... 597
Letters on Practical Subjects..... 598
Electrical Catechism 600
Queries and Answers..... 601
Direct-Current Motors in Brooklyn Navy Yard Shops 602
Turbine Driven Power Plant..... 603
A New Self-Starting Single-Phase Motor 603
Pelton Electric Relay Water-Wheel Governor 604
New Apparatus and Appliances..... 605
A Rising Establishment.....Adv. 35
New Books .....Adv. 35
Obituary .....Adv. 35
Personals .....Adv. 35
Trade Publications .....Adv. 36
Business News .....Adv. 36

Alternating-Current Terminology.

Just as we were getting comfortably settled into terminological ruts again, *L'Industrie Electrique* comes to the front with the suggestion that the list be supplemented by "fictitious power" and "factor of impotence." Fictitious power is intended to express what some careless writers designate "wattless power" (which term is about as accurate as "cold heat" would be); that is, the product of an alternating e.m.f. into the component of current that is 90° displaced from it in phase. The term "factor of impotence" is intended to describe the vector difference between the power factor value and unity; that is, the sine of the angle of lag or lead.

There does not appear to us to be any particular necessity for the terms as proposed. The expression "wattless volt-amperes" is fully as descriptive as "fictitious power," and a rather more accurate definition. And "reactance factor" appears to be far more appropriate as a name for $\sin \Phi$ than "factor of impotence." The numerical value of this wholly mathematical figment is the factor by which the impressed e.m.f. is multiplied to give the value of the reactive e.m.f., so that "reactance factor" is entirely consistent with the existing nomenclature besides being physically descriptive, whereas "factor of impotence" possesses only the latter attribute and is a much more clumsy expression.

If any additions to the alternating-current terminology are to be made, they might profitably consist of names for the arithmetical difference between true watts and apparent watts, and the same kind of difference between power factor and unity, that is, $1 - \cos \Phi$. The mathematician does not need names for $\sin \Phi$ and $E\,C \sin \Phi$ nearly so much as the every-day operating engineer needs names for $E\,C - E\,C \cos \Phi$ and $1 - \cos \Phi$, and the latter individual has no earthly use for hypothetical components and imaginary quantities. He has to deal with apparent and true power and the actual difference between them; if 50 amperes are delivered to a circuit at 2000 volts and the wattmeter shows 80 kilowatts true power, the difference to his mind is 20 kilowatts—of what?

We should say that this is where the term "fictitious power" (or some similar term) would apply. In the case assumed, the power factor is 80 per cent; 20 per cent of the apparent power is not power at all, and if "factor of impotence" were not suicidally unwieldy, it would be a good name for the value 0.20 in this case. It is very doubtful, however, that any station engineer could be induced to use so cumbersome an expression; why not follow the precedent already set and call it either "wattless factor" or "powerless factor?" The bad grammar is no worse than in many of the technical terms that have been adopted already.

Small Central Stations.

It is not very often that one finds a small central station plant installed in conformity with the latest engineering practice, although such examples are becoming more and more frequent as the guiding spirits in this class of station work, by dint of painful experience or through keen observation, come to a realization of the necessity for having only the best. It is a fact not generally appreciated that a plant of small size and located out of immediate touch with any large industrial center demands even closer attention to details which tend to infallibility and economy of operation than more important stations. By reason of their size and location the smaller plants cannot have the benefit of expert supervision and attendance, and must depend for profits more upon the character of their equipment than do the large stations having a thoroughly-trained man in charge of each department. The little plant at Wappinger's Falls, which is described elsewhere in this number, constitutes an example of modern practice along electrical lines that may be safely taken as a guide by the projector or operator of any other central station of similar output.

A notable lapse, however, from the standards followed elsewhere about the installation is shown in the lack of protection for the heated surfaces of the steam plant; the boiler and piping are quite innocent of anything in the form of heat-retaining covering. It is only fair to the engineers who designed and installed the plant to explain that this serious blot on an otherwise praiseworthy specimen of engineering was due not to lack of judgment, but to lack of money. That is, the municipal appropriation was insufficient to provide boiler and pipe covering, as well as one or two minor refinements, and these had to be therefore omitted. Happily, this is not one of those cases that one so frequently finds, where the holders of the purse strings are parsimonious and refuse pig-headedly to pay for refinements leading to ultimate economy. Everyone concerned in the present case appreciated the expediency of protecting the heated surfaces, but there were not sufficient treasury funds available for the work and it was considered inadvisable to strain further the generosity of the taxpayers at the moment.

The Rating of Enclosed Machines.

The high efficiency of a draft of air in cooling a heated object is demonstrated in the most commonplace occurrences every day—a very appropriate, though somewhat unseasonable instance being that of the now invaluable electric fan. Notwithstanding this, we are frequently asked why an enclosed dynamo or motor is rated higher when openings in the end caps are left uncovered than when they are closed, no other change being made in the machine. A little reflection will show that the heat evolved within a completely enclosed machine can be got rid of only by transmission to the shell, partly through the contained air and partly through the magnet poles, and through the metal of the shell to the surrounding air; whereas openings in the case permit the heated air within to come out and cooler air to take its place, a large portion of the total heat being thus carried off without having to be transferred from molecule to molecule of comparatively still air. Consequently, a semi-enclosed machine has practically all the ability to dissipate heat by conduction to and radiation from the outer shell that a completely enclosed machine has, and it has in addition the great advantage of convection, or the carrying off of heat by moving currents of air.

The output of a dynamo or motor of proper design is limited solely by the heating or temperature elevation of its parts, and the extent to which the temperature can be kept down depends entirely upon the facility with which the heat can be got rid of as it is evolved. Therefore, the permissible output of a machine when enclosed is necessarily less than when it is ventilated. The ratio between the two outputs for a given size of machine depends on the proportion of the total heat dissipation that is effected in the ventilated form by convection. Usually, a machine is made to yield about two-thirds the output when enclosed that it does when ventilated, and this is accomplished by increasing the speed from 5 to 10 per cent. This is a considerable sacrifice to make for the sake of complete enclosure, but there are so many places in which this is indispensable that a refusal to conform to the conditions would mean industrial suicide. It is a little odd, however, that electrical designers have not taken a leaf from the experience book of the builders of internal combustion engines and added hideous but efficacious radiating ribs to the shells of enclosed dynamos and motors.

Water Wheel Efficiency and Operation.

The actual efficiency of water wheels has not been a matter of much concern on the part of users until very recent years, in which long-distance electrical transmission has put a premium on every unit of power that can be made available from a given stream of water. And even now there is more haziness about the efficiency of this form of prime mover than about that of any other important piece of apparatus used in a power plant. The main reason for this is that builders of water wheels have not, and in the very nature of the case cannot have, factory facilities for making efficiency tests of their product. This condition is scarcely susceptible of correction; water power sites of importance are not, as a rule, favorably located for this class of manufacturing industry.

While it is true that efficiency tests might be made at the places where the wheels are to be operated, such tests, to amount to anything, would entail numerous objectionable complications; moreover, the tests would be of little or no value to the manufacturer in the way of enabling him to improve his product. Of course we do not overlook the facilities of the testing flume at Holyoke, but a test there is extremely expensive for distant builders of wheels, and when obtained does not meet fully the requirements for a factory test with a view to locating weak spots in the design.

Occasional tests of water wheels have been made by users in order to satisfy their own desire to know just what they were doing, and such tests have almost invariably revealed an efficiency considerably below what was expected. Tests made in the far West on impulse wheels have demonstrated pretty conclusively that a full load efficiency of 80 per cent is not attainable, and that the reduction at lower loads is such that an all-day efficiency of 60 per cent is considered extremely good. This is approximately true of turbines also.

After considering the foregoing figures, it does not require a phenomenal order of sagacity to arrive at the conclusion that in laying out a water-wheel plant, the aim should be to choose units of such size that at least during the period of high load curve the wheels would be working somewhere near their maximum capacity. That is to say, the plant should be so divided up that large differences (not meaning momentary fluctuations, of course), in the load could be met by starting up or shutting down wheels and generators. This condition is modified greatly by multiple-nozzle impulse wheels, which have practically the same efficiency when running with one nozzle unthrottled as with two, three, four or any other number, the speed being unchanged. With a four-nozzle wheel, therefore, practically full-load efficiency is obtainable at quarter load by using only one nozzle "wide open" or undeflected.

Such an advantage is inherently impossible to the older and more familiar turbine type of wheel. We believe an attempt was made once to increase the partial-load efficiency of the turbine by means of adjustable buckets, but a consideration of the principles of turbine operation shows the futility of such a plan, even if the resulting mechanical complexity were not prohibitive. However this may be, there remains at present no means of obtaining reasonable efficiency at light loads, so that in turbine-driven plants it is even more imperative than in impulse-wheel plants to divide up the generating units in such wise that the number of wheels in use shall be roughly proportional to the total load and as little throttling done as possible.

This is most important in those plants afflicted with an irregular water supply and having to run in dry seasons from a reservoir; the higher the wheel efficiency, the longer will the reservoir keep the plant going under a given condition of load. Even if the water-power plant be supplemented by an emergency steam equipment, the requirement still obtains for maximum production by water power alone; although in this case the absence of liability to a disastrous reduction in output by reason of water scarcity considerably tones down the importance of turbine efficiency.

DESIGN FOR A 1-H.P. GAS ENGINE.

BY J. C. BROCKSMITH, M. E.

The gas engine of which a description and working drawings are here given was designed for and will develop continuously one brake horse-power at the moderate speed of 500 r.p.m. It operates with either gas or gasoline as fuel, and when used for electric lighting gives perfectly uniform light by direct belting of the generator to the engine fly-wheel. The engine is especially designed for electrical work, having unusually large fly-wheels, bearings of liberal proportions and heavy, substantial construction throughout. No effort has been made to save weight, as the engine is intended for stationary work only; it will weigh upward of 300 lbs. complete, of which the fly-wheels alone constitute nearly 60 per cent.

The piston area is approximately 9 sq. ins. and the stroke 5 ins., which makes the stroke volume 45 cu. ins. With a piston speed of 415 ft. per minute, the developed power is one brake horse-power. But as piston speeds up to 600 ft. per minute are considered good practice, it would be practicable to increase the rotative speed to 720 r.p.m., at which the output would be 1½ horse-power. Also at half the normal speed (250 r.p.m.) the engine develops a full half horse-power. As shown in the drawings, this engine works with a moderate compression; the clearance shown being 33 per cent of the stroke volume. The amount of the clearance, however, can be readily varied for experimental purposes, either by lengthening the connecting rod by means of washers inserted at the crank end of the rod, or by means of cast-iron blocks placed in the cylinder. Increasing the compression raises the mean effective pressure in the cylinder, and consequently increases both the power and efficiency of the machine. Clearances as low as 16 or 20 per cent may be used without danger of pre-igniting the charge.

The problem of proper ignition in gas engines is one of the greatest difficulty. Some one has aptly said that a gas engine consists of a spark with an engine built around it, and indeed the builder of a small gas engine is likely to find that the problems of proper mixture, compression, etc., are simple in comparison with the spark problem. The igniter shown on this engine is a very simple form of contact sparker, operated by the piston, which has shown itself capable of operating 8 and 10 hours consecutively without any trouble whatever. The builder will probably find it interesting, however, to experiment on different forms of sparkers, including the now very popular jump spark, any one of which can be readily applied to the engine in place of the regular sparker.

To secure a proper mixture and proportion of the fuel and air which enter the engine cylinder is a problem which is second in importance only to the spark problem. In operating this engine on gasoline, the fuel is fed drop by drop into the chamber immediately behind the inlet valve, where it falls upon a roll of wire gauze, and the air entering from below carries it in the form of vapor and spray directly into the cylinder. The flow of gasoline is regulated by means of a needle valve provided with a peep-hole somewhat after the manner of a sight-feed lubricator, so that the feed can be inspected and adjusted at all times.

For operating on gas, a short piece of 1-in. pipe is provided, drilled with a number of air holes around the base, into the bottom of which issues a ⅛-in. gas jet. The pipe is screwed into the lower portion of the inlet valve chamber. This device constitutes a Bunsen burner similar to the ordinary laboratory burner, except that it is larger, and the mixture instead of burning at the top of the tube passes directly into the engine cylinder during the suction stroke. Obviously it is possible, with the arrangement used, to change the fuel from gas to gasoline, or the reverse, without stopping the engine, by simply turning off the one and turning on the other, provided both have been previously adjusted to give a correct running mixture.

It will be found that for any given rate of flow of the fuel the speed of the engine will tend to remain within certain limits, regardless of the load and regardless of any governor action. This is due to the fact that any increase in speed due to a removal of the load will cause a greater amount of air to be drawn in per unit of time, thus impoverishing the mixture and causing the explosions to become weaker, while an increase of load will tend to decrease the speed, causing a

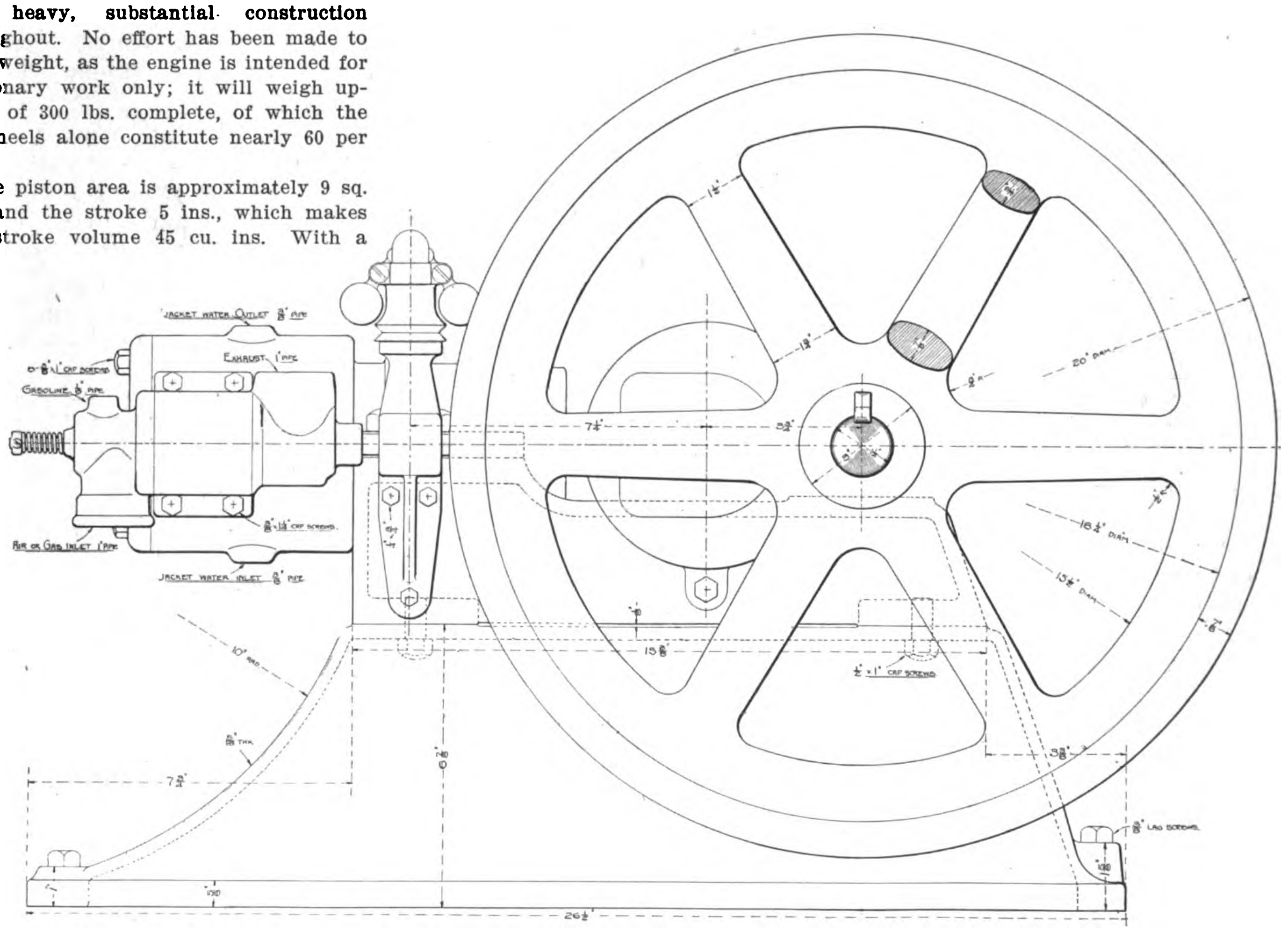


FIG. 1.—SIDE ELEVATION OF GAS ENGINE.

richer mixture and consequently stronger explosions to meet the increased load.

Good compression is a matter of considerable importance. The piston of the engine should travel freely, and at the same time be so perfectly fitted to the bore of the cylinder as to allow no leakage of the gases under high pressures. This is a matter of mechanical detail which should receive the closest attention when the work of construction has proceeded that far.

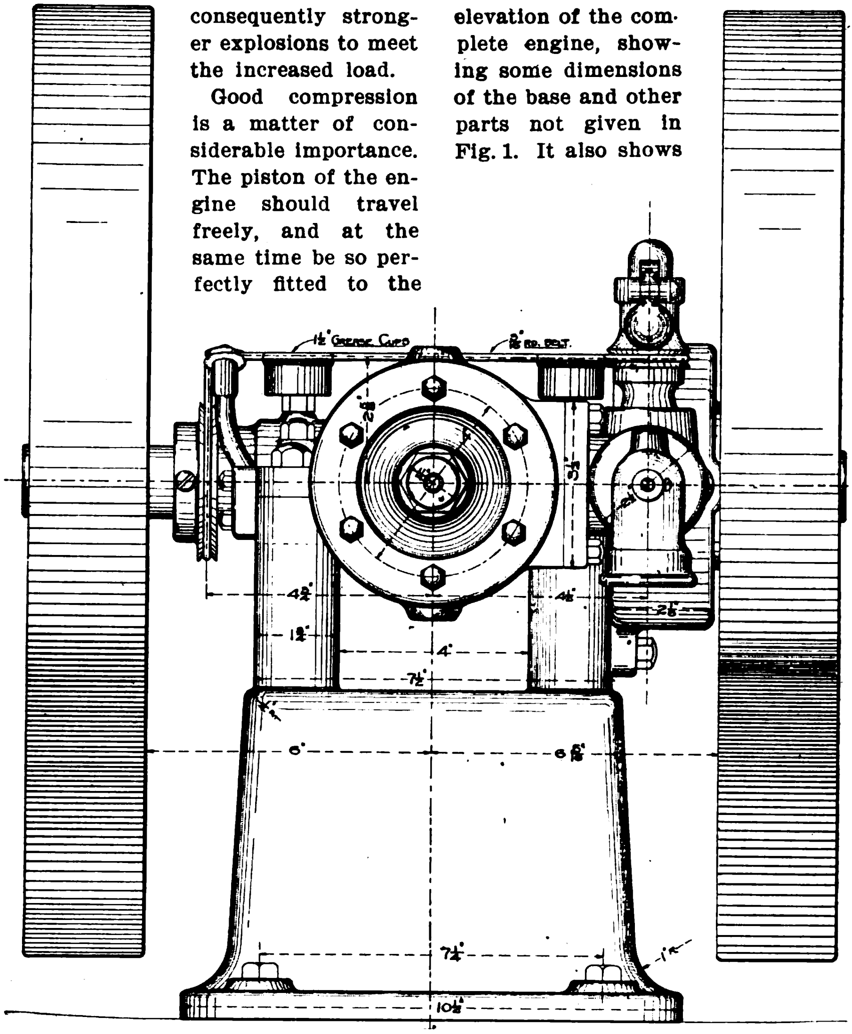


FIG. 2.—END ELEVATION OF GAS ENGINE.

CONSTRUCTION OF THE ENGINE.

Fig. 1 shows a side elevation of the complete engine. It is intended that this drawing be consulted for the proportions of the fly-wheels and the base in laying out the patterns for these parts. The wheels are 20 ins. in outside diameter and have six arms, each wheel weighing about 90 lbs., finished. Two wheels are required, the two being exactly alike. The rims should be turned on the face and the flat portions at the sides faced off. The hub should be faced off on both sides and bored to 1½ ins. for the crank shaft. If in addition to this the rims are polished it will add much to the appearance of the machine.

The base is a simple box-like casting, with sloping sides and ends to permit easy moulding. The pattern is to be made of 5/16-in. stuff, and no core is required for the inside. This view also shows the location of the valve chamber on the side of the cylinder, the position of the various supply and exhaust openings, and the placing of the governor to act directly upon the exhaust valve stem.

Fig. 2 is an end elevation of the complete engine, showing some dimensions of the base and other parts not given in Fig. 1. It also shows the method of belting the governor from the opposite side of the crank shaft by the use of a pair of idler pulleys. The layout of bolts on the cylinder head is to be noted in this view; the diameter of the circle of centers is 4 ins., and they should be spaced as here shown, to avoid the possibility of drilling through into the port connecting cylinder and valve chamber.

Fig. 4 is a sectional plan of the engine, which shows, perhaps, more clearly than any of the other drawings all the working parts of the machine in their proper proportion and relation to each other, and supplies details and dimensions of parts not given in other views. The cylinder, piston, valve chamber and fly-wheel are shown in section, exposing to view the valves, igniter, connecting rod and bearings, also the top half of the gear case is represented as removed, as is the cap of the main bearing, showing the 2 to 1 reduction gears for operating the exhaust valve, the cam, contact maker, etc. The section of the fly-wheel brings out the form of the rim, thickness of the arms, length and diameter of hub and other dimensions not already given in other views.

The igniter, which is also shown in this view, consists of a ¼-in. rod of yellow brass, or steel tipped with yellow brass, sliding in a brass bushing insulated from the cylinder head by means of 3/32 mica all around. The rod has a collar ¾ in. in diameter near the center of its length, against which is placed some mica washers, and upon which in turn an open coil spring bears. The whole is enclosed by a piece of ¾-in. iron pipe, the rod passing through the closed end of the pipe with about 1/16 in. clearance all around. The outside end of the rod has a small hole drilled through it for a wire connection, and the inside end comes in contact with the head of a small brass screw in the piston head.

The bearing for the piston end of the connecting rod is sufficiently well shown in this view to require no further detail-

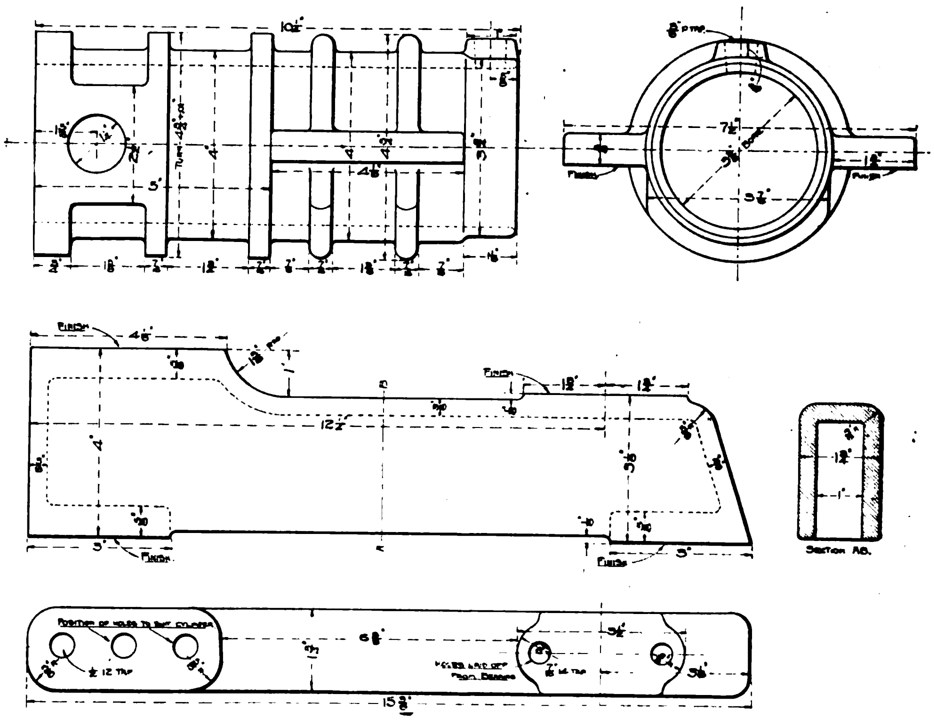

10½
5
4
7½
5¼
Finish
4⅝
12½
Section AB
6⅛
15⅜
½ tap
Position of holes to suit cylinder
Holes laid off from centers

FIG. 3.—DETAILS OF CYLINDER AND SIDE FRAMES.

ing. It consists of a brass casting having a cylindrical portion 1¾ ins. in diameter by 2⅛ ins. long, which is bored 1⅛ ins. to receive the wrist pin. It also has a lug cast on at right angles to the main portion which is drilled and tapped ¾—10, to receive the threaded end of the connecting rod. When this bearing becomes worn it may be split along one side and a cap screw inserted to draw the parts together, thus taking up the wear.

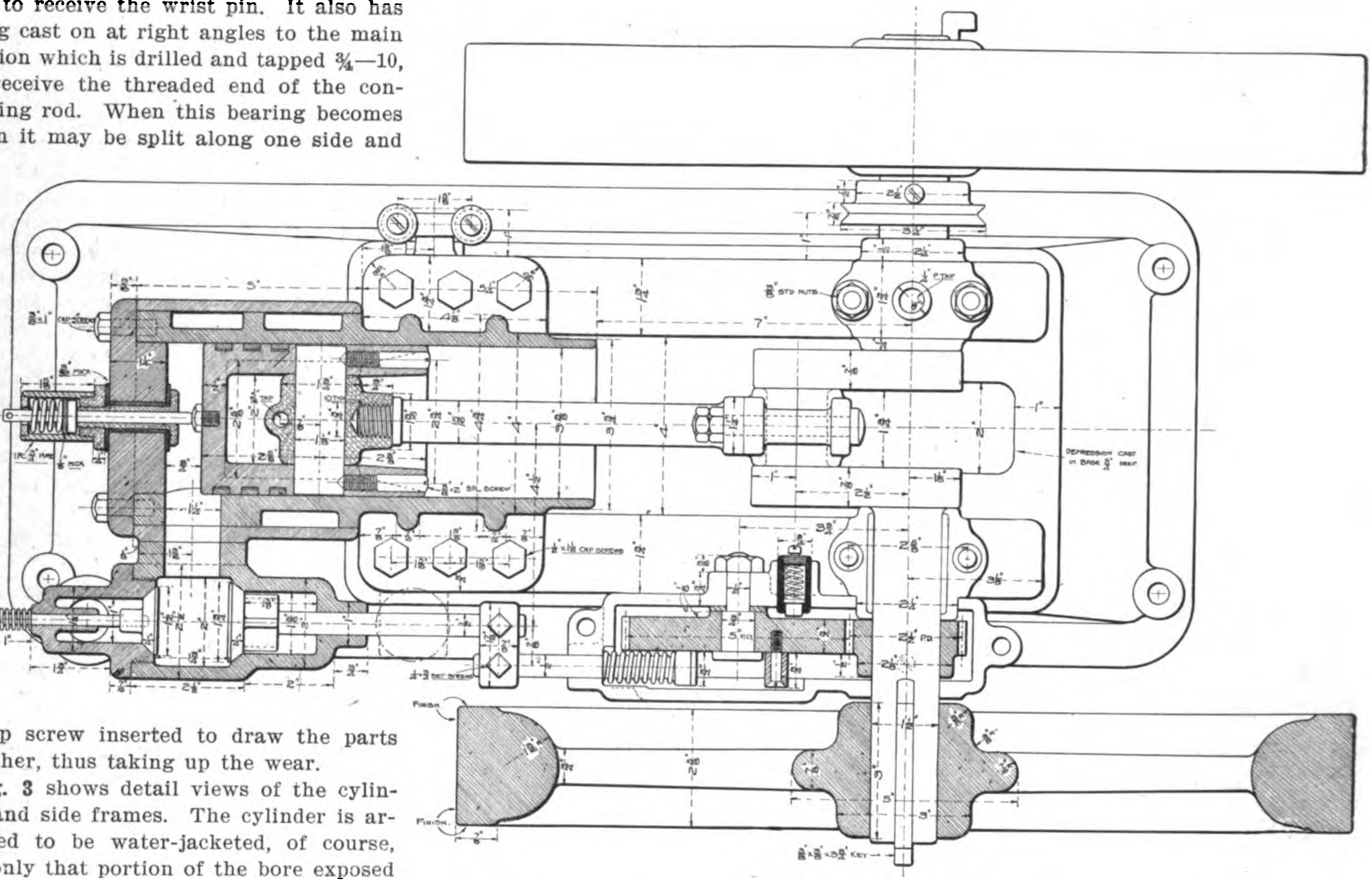


FIG. 4.—SECTIONAL PLAN OF GAS ENGINE

Fig. 3 shows detail views of the cylinder and side frames. The cylinder is arranged to be water-jacketed, of course, but only that portion of the bore exposed to the hot gases is cooled in this manner, the other portions being sufficiently well cooled by conduction and radiation to require no water cooling. The intricate job of coring usually necessary in water-jacketed cylinders is avoided in this engine by making the outer shell of the jacket a separate casting to be shrunk on the cylinder after both parts have been finished. The cylinder itself is a perfectly simple casting, the only core necessary being for the bore, which is cored about ¼ in. smaller than the finished size. Two ears are provided at the sides of the cylinder for bolting it to the frame. The cylinder casting is first bored to the finished size, care being taken to have the bore perfectly cylindrical and as smooth as possible; it is then mounted on a mandrel, and the portion which is to receive the water-jacket casting is turned off to a diameter slightly greater than the finished bore of the jacket, the allowance for shrinking on being from 75/1000 to 1/100 in. The end of the cylinder should be faced off at the same operation.

A lug is provided at the rear end of the cylinder, which is to be tapped with a ⅜-in. pipe tap for receiving a lubricator or sight-feed oiler of any approved type for oiling the piston. It might be thought from the location of the oiler, so near the end of the piston travel, that the front end of the cylinder would receive little or no oil; experience has shown, however, that oil from this aperture finds its way to all parts of the cylinder in ample quantity, some of it even passing out through the exhaust valve.

The castings which form the side frames of the engine would properly be rights and lefts; the difference between the two is so slight, however, that if both are made as shown in Fig. 3 they will answer the purpose equally well. But one pattern and core box will in this case be necessary, the casting being cored hollow, as indicated by the dotted lines.

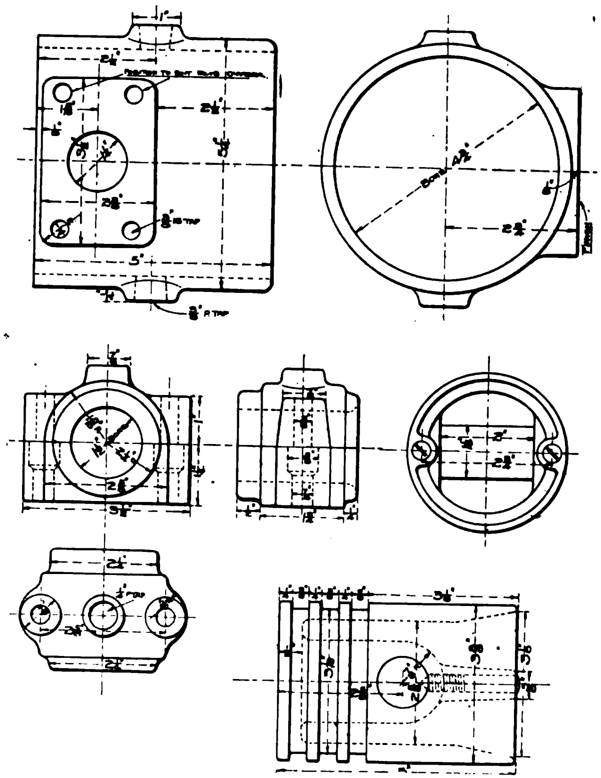


FIG. 5.—CYLINDER JACKET, MAIN BEARINGS AND PISTON

In finishing these castings they are to be planed on top where the cylinder and main bearings bolt to them, and on the bottom where they bolt to the base. The bolt holes have not been definitely located, as it is intended that these should be laid off from the parts which are to be fastened on after the machine is ready for assembling.

In Fig. 5 is shown the cylinder jacket, main bearings and piston. As the jacket casting is only ¼ in. in thickness, some care will be necessary when boring it out not to grip it so tightly in the chuck as to spring it out of round, for then it will never be water-tight after it is shrunk on. After being bored to the proper diameter, the casting is to be heated slowly and uniformly until colors begin to appear on the finished portions, when it will be found to have expanded sufficiently to slip freely over the finished end of the cylinder; it should then be quickly adjusted to the proper position and allowed to cool slowly by itself. If this is carefully done the result will be very satisfactory, and for all practical purposes quite as substantial as a cylinder and jacket cast in one piece. The holes for the jacket-water inlet and outlet should be drilled and tapped for ⅜-in. pipe before the jacket is shrunk on, and the center rib on the cylinder must be cut away slightly at both top and bottom immediately opposite these holes so that the jacket water may have free entrance and exit; this should be done on the pattern, of course. The seat provided on the outside of the jacket for receiving the valve chamber may be planed after the jacket has been shrunk on, and a 1¼-in. hole is to be drilled through into the bore of the cylinder.

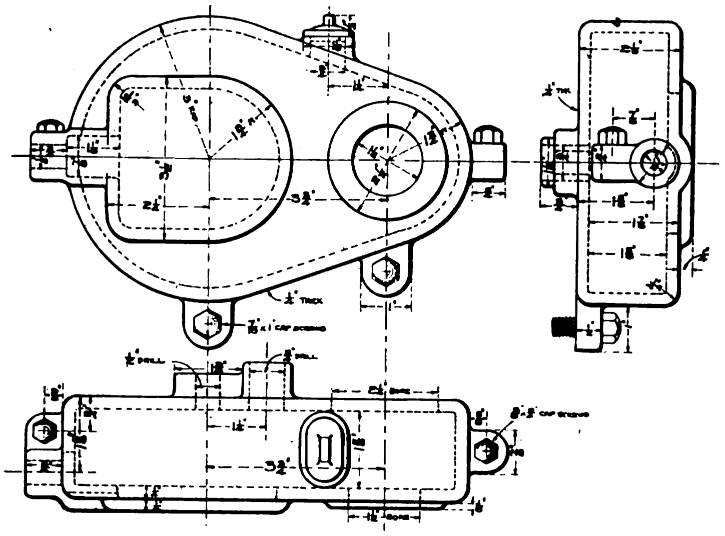


FIG. 6.—DETAILS OF CAST IRON CASE.

The main or crank-shaft bearings are made in halves, the lower half being fastened to the side frame by means of studs and the cap being held on by a pair of ⅜-in. standard hexagon nuts screwed to the top of these same studs. The bore of the bearings should be cast considerably larger than the finished crank-shaft, in order to allow for a lining of babbit metal, which is to be poured in. Each bearing is also provided with a lug on top, drilled and tapped for ¼ in. pipe for a grease cup. Two bearings are required, just alike in all respects, except that the one on the gear side of the engine has the projecting portion turned off to 2¼ ins. diameter to fit the bored hole in the gear case.

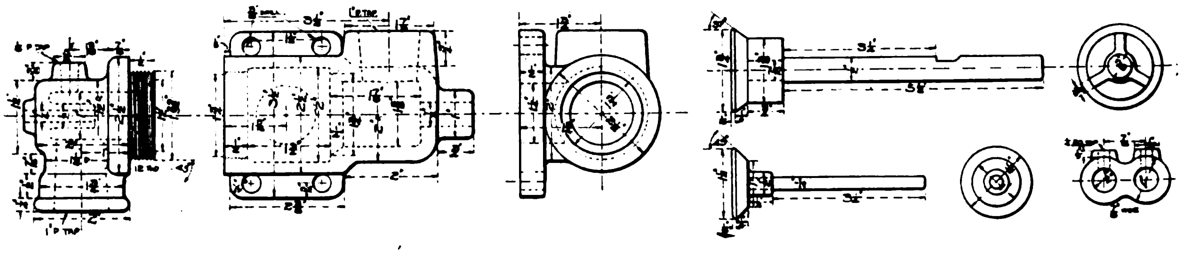


FIG. 7.—DETAILS OF VALVE CHAMBERS AND VALVES

The piston is of very simple construction, and its casting requires no coring, as is usually necessary for the interior. In finishing the piston, the outside is turned smooth and cylindrical and of such diameter that considerable effort is required to push it through the finished bore of the cylinder by hand. At the same time three grooves are turned to receive packing rings, and it is well to have these on hand finished, so that the grooves may be made just the proper width to accommodate the rings, it being easier to make the groove fit the ring than *vice versa.* A 1⅛-in. hole is drilled through the piston at right angles to its axis for receiving the steel wrist-pin, and two smaller holes are drilled and tapped to receive set screws for holding the wrist-pin in position.

The packing rings are to be turned from an iron casting made specially for them, and should be finished a full sixty-fourth inch larger than the bore of the cylinder, and ⅛ in. thick. They are cut off ⅜ in. wide and split at one point by a diagonal saw cut, and are then tried in the bore. If necessary, the abutting ends of the ring may be filed until they stand a trifle apart when inserted into the bore; this is to allow for expansion when they become heated. When the rings have been prepared in this manner and it is seen that they will fit their respective grooves, they are sprung over the end of the piston and into their places.

To the amateur performing this operation for the first time it will appear as if the rings must certainly break, the ends standing about ¾ in. apart while passing over the end of the piston. They will withstand this rough usage, however, if the iron is of fair quality. Each ring should be pinned to the piston so that the joints come at intervals of 120 degrees, the pins preventing the rings from turning and yet not preventing free motion in other directions. If any part of the piston construction is not clearly understood from an inspection of the views in Fig. 5, doubtless this will be made more clear by the section shown in Fig. 4.

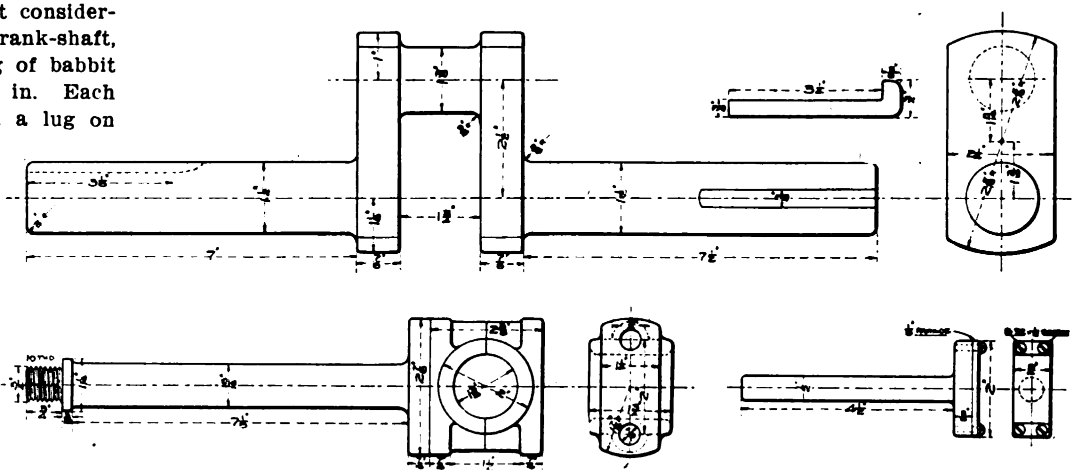


FIG. 8.—STEEL FORGINGS AND OTHER STEEL DETAILS.

Fig. 6 gives several views of the cast-iron case which contains the reducing gears and cam for operating the exhaust valve, and the contact maker for cutting out the igniter at each second revolution. It will be understood, of course, that the engine works on the 4-stroke or Beau de Rochas cycle, in which the exhaust valve is required to remain open during one stroke out of the four constituting a cycle. The reducing gears have a ratio of 2 to 1, the small gear on the main shaft having a pitch diameter of 2½ ins. and 30 teeth, the large gear having 5 ins. pitch diameter and 60 teeth. Both gears are 12 diametral pitch, are 3¾ ins. between centers and have a ¾-in. face. The gear case is made in halves and bolted together by means of ⅜-in. cap screws; the two halves being quite different, a pattern will be required for each, but these can be quite simple, as no coring is necessary. In finishing the castings for this, the two halves are first planed upon the surfaces which come together, then are bolted together and the whole mounted upon the face plate of the lathe to bore out the large holes at one end of the case. One side is bored out 2½ ins., the other side 1½ ins., both being done at one setting of the case. It is then removed from the lathe and the smaller holes drilled, a 1½-in. hole at the front end for the cam rod, a ⅜-in. hole through the lug on the side for inserting the contact maker, and a ½-in. hole for the secondary gear stud, care being taken to have the latter exactly 3¾ ins. from center to center of the larger hole at the end where the crank shaft passes through. Also 7/16-in. holes are drilled through the lugs at the bottom of the case for bolting it to the frame of the engine.

The contact maker, which is required to go on the side of the gear case, consists of a small brass button pressed toward the gear by means of a small coil spring behind it, and the whole enclosed in a hard-rubber sleeve, which is made of such diameter that it is firmly held when the two halves of the gear case are drawn together. The button makes contact with a small brass plate riveted to the face of the large gear in such a position that the two will come in contact at the end of the compression stroke, and remain so until after the beginning of the expansion stroke. At all other times the circuit through the igniter is open at this point, the button having a shoulder which, engaging a similar shoulder in the rubber sleeve, prevents it from coming out and touching the face of the gear. This same contact maker may be used to break the primary circuit of an induction coil in case a jump spark is used.

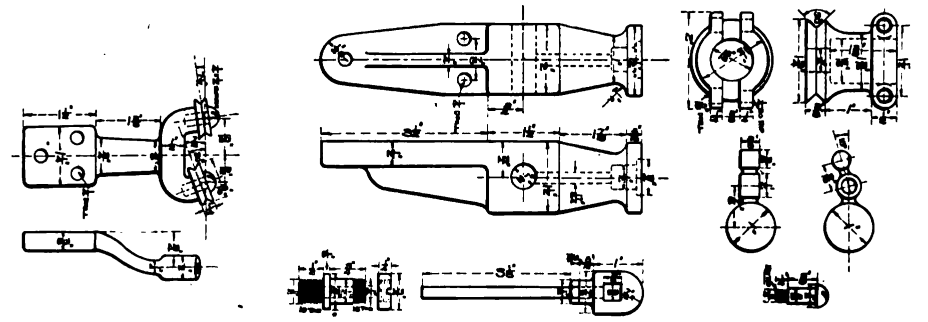


FIG. 9.—DETAILS OF GOVERNOR.

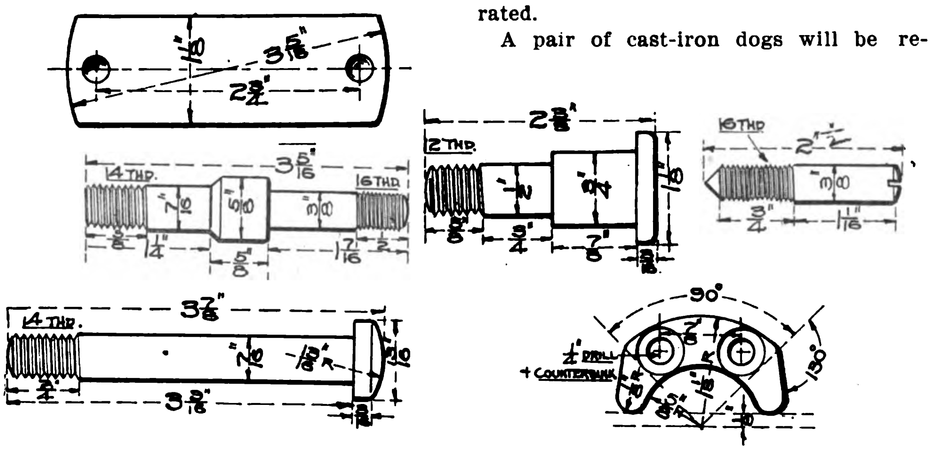


FIG. 10.—ADDITIONAL DETAILS OF STEEL PARTS.

Fig. 7 gives the details of the valve chamber and valves. The valve chamber is made in two parts with a screw joint between, which permits of ready access to the valves for the purpose of cleaning and grinding in when this becomes necessary. The larger portion of the valve chamber has a flat surface cast on at the back, which bolts tightly to a similar surface on the cylinder jacket. These should be planed and finished to a close fit. The valves themselves are made of cast iron, with stems of Bessemer steel rod screwed in. After being turned as nearly as possible to the proper angle of the valve seats, they are to be ground into their respective seats with emery and oil until a perfectly gas-tight joint is obtained. When used on gasoline the space behind the inlet valve should be packed with some brass wire gauze, of about 60 mesh, loosely rolled. This figure also shows a small cast-iron coupling for joining the exhaust valve stem to the cam push rod.

All parts thus far described have been of cast iron. Figs. 8 and 10 illustrate all the steel parts which are required for the engine, some of these being steel forgings, while others can be conveniently turned out of mild steel rod. The crank shaft is a forging of mild open-hearth steel, the center portion being forged as a solid block and the surplus metal between the arms of the crank being removed by drilling a series of holes and knocking out the piece thus separated.

A pair of cast-iron dogs will be required to slip over the ends of the shaft and upon which to locate the centers for turning the crank pin and for finishing the ends of the arms, which are to be turned to a circular arc 2 5/16 ins. radius. The ends of the shaft are first turned to within about 1/16 in. of the finished size, and the dogs are then fitted on. The crank pin is then turned and finished to size, and the sides and ends of the arms faced off. The shaft is again mounted on its own centers and finished down to size. Two keyways are cut, one at each end of the shaft, ⅝-in. wide and 3/16-in. deep, and if this is done with a milling cutter the cut should be made sufficiently long to give fully 3 ins. of flat surface along the bottom of the way. The keys themselves consist of ⅝-in. square steel with the ends turned up at right angles to facilitate their removal.

The connecting rod is a plain round forging of soft steel with a T-head at one end, to which the crank-pin brasses are bolted. The brasses are shown in position, but the bolts for same are seen in a separate detail. The connecting rod is to be turned 15/16 in. in diameter throughout its length, with the exception of the shoulder and screw thread at the piston end of the rod, which is ¾ in. in diameter and 10 pitch. Also the ends of the T-head are turned off to a circular arc and the sides faced off. The rod is then polished all over.

The push rod which operates the exhaust valve consists of a plain round stem with a T-head against which the cam works. The head is faced with ⅛-in. rawhide, which obviates the noise incidental to opening the valve against pressure. The leather wears a long time and can be readily replaced by taking out the four small screws which hold it in place. The studs for the main bearings, of which four will be required, can be turned from steel bar. They are ⅜ in. at one end, 7/16 in. at the other, with a collar ⅝ in. in diameter near the center.

The cam may conveniently be a steel forging. It should be first drilled and countersunk for two ¼-in. flat head screws. It may then be fastened to the face of the gear and the surfaces turned to the proper circular arcs. Note the angle of the flat surfaces; these may be filed to a finish. The cam is designed to open and close the exhaust valve abruptly, and hold it open and motionless during one stroke of the piston or 90 degrees revolution of the secondary gear. The lift of the valve will be about 3/16 in., as here shown, but it can readily be made any desired amount by adjusting the position of the small coupling which connects the push rod with the valve stem. The time of opening and closing is adjusted by shifting the small gear around the main shaft, to which it is secured by a set screw. The duration of valve opening can only be adjusted by changing the length of the working face, that is, by filing the ends. The secondary gear shaft, wrist-pin and set-screws for the same are all simple pieces to be turned from cold rolled steel; the drawing shows all necessary dimensions.

Fig. 9 gives the details of the governor, together with the idler pulleys for operating it from the crank shaft of the engine. The governor acts directly upon the exhaust valve by holding the valve open when the speed is high, thus causing the piston to draw in only pure air, and allowing the valve to resume its regular functions when the speed becomes normal again. Just here it may be stated that if the load on the engine is moderately steady, and very exact regulation is not required, it will give good satisfaction operating entirely without a governor, for reasons which have already been explained, and as the governor requires considerable careful work in fitting it up this may well be dispensed with if the conditions of operation are as stated.

In conclusion, it may be well to state that an engine built according to the foregoing designs has been in successful operation for a period of three years, so that the builder of this machine, if he performs the mechanical work carefully, need have no fear for the satisfactory operation of the completed engine.

CALORIMETRY.

BY CHAS. L. HUBBARD.

THE SEPARATOR CALORIMETER.

The results obtainable by using the separator form of calorimeter are much more accurate and reliable than those given by the barrel calorimeter. The separator calorimeter is similar to a steam separator on a small scale; its general form is shown in Fig. 1. The apparatus consists of a chamber, *A*, about 12 ins. long and 3 in diameter, into which the steam pipe, *P*, leads from the boiler. That portion of the pipe within the calorimeter is perforated with a large number of small holes, about ⅛ in. in diameter. The steam leaves the calorimeter by the pipe, *S*, across which extends a diaphragm having in its center an opening about 1/16 in. in diameter. The water level in the separator chamber is indicated in the gauge glass, *C*, and the level is recorded by means of a pointer or thread tied around the glass. Steam from the boiler enters the calorimeter through the pipe, *D*; its velocity is checked by the abrupt change in the direction of flow, and the particles of water in suspension fall to the bottom of the chamber, *A*. The dry steam escapes at *S* and is led into a tank of cold water to be condensed and weighed. The pipe, *F*, is for the connection of a steam gauge for use under conditions to be described later.

In the use of this instrument it is usual to lead a hose from the exhaust outlet, *S*, to a condensing vessel and condense the delivered steam for a period of one-half to one hour in length. This is readily done, since with steam at 80 lbs. pressure the weight of dry steam that will escape through the diaphragm orifice in an hour will not be much over 12 lbs., and the condensing vessel required need contain only about 200 lbs. of cold water. The water in the calorimeter, which represents the moisture in the steam and condensation due to radiation from the instrument itself, should be drawn off during the test at such a rate as to keep it at a fixed level; this may be accomplished by setting the cock, *E*, at the bottom of the glass so that it will drip slightly. This water may be discharged directly into a glass flask and will generally be sufficiently cool to prevent any loss by vaporization.

No reading of temperatures or pressures is required in this process. The weight of dry steam discharged in a given length of time is determined by the increase in weight of the condensing water, and the weight of entrained water thrown down by the calorimeter plus the condensation in the calorimeter itself is found by weighing the water drawn off through the cock at the bottom of the gauge glass. The proportion of condensation due to radiation from the calorimeter may be readily determined by attaching a second calorimeter to the exhaust from the first one. In this case, perfectly dry steam will be received in the second chamber, and any moisture deposited there will be due to condensation from radiation loss. Since the chambers are of the same size this quantity may be used as a correction of the amount deposited in the first chamber.

After the apparatus is connected ready for use, steam should be allowed to flow through it, and when it has attained uniform conditions the cock, *E*, may be set so as to discharge water at such a rate that the level in the glass will remain constant. Then the condensation of the steam from the exhaust and the collection of the water discharged from the cock, *E*, should be begun *simultaneously*. At the end of the test, care should be taken to have the water in the gauge glass stand at the same level as in the beginning.

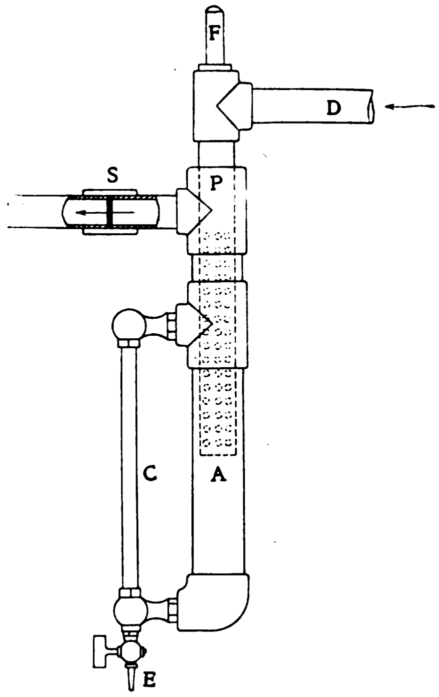


FIG. 1.—SEPARATOR CALORIMETER.

In case it is not convenient to condense and weigh the steam, a pressure gauge may be attached at the point *F* and the flow of steam computed by Napier's formula,

$$Q = \frac{P \times A}{70} \quad \ldots\ldots\ldots\ldots (1)$$

in which *Q* represents the flow of steam in pounds per second, *P*, the absolute pressure in the calorimeter (the gauge pressure + 14.7), and *A*, the area of the orifice through the diaphragm in square-inch measure. If this is done, great care must be taken in measuring the opening through the diaphragm before each test.

The working formulas for the separator calorimeter are given below:

$$x = \frac{W + R}{W + w} \quad \ldots\ldots\ldots\ldots (2)$$

$$m = 1 - x = \frac{w - R}{W + w} \quad \ldots\ldots (3)$$

in which

x = quality of the steam;
m = proportion of moisture in the steam tested;
W = weight of dry steam discharged at the exhaust orifice;
w = weight of water drawn from the calorimeter, and
R = weight of steam condensed by radiation, as shown by the second calorimeter.

Example: Suppose a test shows the increase in weight of the condensing water to be 18.6 lbs.; the water drawn from the first calorimeter 1.2 lbs., and that from the second calorimeter 0.3 lbs. What is the quality of the steam? In this case we have

$W = 18.6$
$w = 1.2$
$R = 0.3$,

and substituting in equation (2) we get

$$x = \frac{18.6 + 0.3}{1.2 + 18.6} = .954, \text{ or } 95.4 \text{ per cent.}$$

It is easy to see by inspection that the percentage of moisture in this case is 4.6 per cent., but if one wished to ascertain primarily the moisture percentage, it would be a trifle more direct to use formula (3).

TELEPHONE EXCHANGE NOTES.

BY W. S. HENRY.

A complete telephone exchange system may be divided into three parts; first, the apparatus and equipment of the central exchange; second, the outside overhead and underground line work; third, the instruments and wiring on the premises of the subscriber. Considering the low rates generally charged in small towns, telephone companies located in such places cannot afford to do much, if any, underground construction if they expect to pay any dividends, so that underground lines need not be considered here.

The subscriber's telephone should be placed in a convenient place, and if possible, upon a solid wall. A protector should be placed as near as possible to the point where the outside wires enter the building. There are various kinds of protectors. One kind quite extensively used consists of a heat coil that will open the circuit if three-tenths of an ampere flows through it for 30 seconds, and will ground the line by melting a fusible button in a cavity between two carbon plates if a lightning discharge comes in over the line wire. These should, of course, be double-pole. One sneak current protector, as the heat coil is called, should be connected directly in series with each line wire, and to each line wire is also connected one carbon plate separated by a small air-gap or piece of mica from another carbon plate connected permanently to ground. The telephone should be connected to the heat coil end of the protector. Some protectors have a 1½-ampere fuse in place of the carbon plates. The protector should not be nearer than 6 ins. to any curtain or other inflammable material.

The wire from the telephone instruments to the protector should preferably be No. 18 B. & S., twisted together in pairs. The insulation should be what is known as damp-proof office wire. The most rigid specifications require the inside wire to be supported on No. 6½ porcelain knobs placed about 4 ft. apart. However, this is seldom lived up to. These wires are frequently run in molding, which makes a neat job. Wherever the wires pass through walls, floors, casings, or other partitions, smooth glazed clay tubes should be used. They vary from 4 to 10 ins. in length, have an inside diameter of ⅜ in. and an outside diameter of ⅝ in. The tube used should be long enough to project out about 1 in. on the side opposite to the head. All joints in the wire between the telephone and the protector should be strong mechanically and should be soldered without acid; rosin or other non-acid flux may be used. The joints in the two wires should not be opposite one another, but an inch or so apart. In making the joint, make several turns of the bare end of each wire around the insulation to hold it firmly, so that it cannot unravel or slip back. After it is thoroughly soldered, the joint should be covered with adhesive tape.

The wires from the outside pole or other support to the protector just inside the building should be No. 14 B. & S. rubber-covered and braided copper wire, and for complete metallic circuits, twisted together in pairs. The outside line wires, which may consist of bare wires strung overhead on poles, overhead or underground cables, all come together at a pole, or underground near the exchange, or on the roof of the building. The bare overhead conductors should terminate in cable boxes on the pole or building, and be collected into one or more cables. The cables may enter the building through a special opening opposite the pole or underground into the cellar. Inside the building the cables may terminate in cable-heads, boxes, or pot-head terminals. The wires, still in the form of a cable, then pass to one side, usually the vertical one, of a distributing board. On this side of the distributing board are located the protecting devices, consisting usually of a fuse or heat coil and some kind of lightning arrester.

Where complete metallic circuits are used, some part of which consist of bare overhead wires or are run through overhead cables, there should be a lightning arrester and heat coil or fuse in each line wire; that is, one in each side of a complete metallic circuit. In circuits that are entirely in underground cables the lightning arrester part of the protector may be omitted. Sometimes the protecting devices are mounted on the cable-head or box.

From the vertical side of the distributing board the circuits are carried to the other side of this board, where the terminals are usually arranged in horizontal rows. The terminals on the vertical and horizontal sides are connected together, usually by wires called "jumpers." For this purpose a good quality of rubber-covered tinned-copper wire, about No. 16 or 18, should be used, and the wires should be bought twisted together in pairs if the distributing board is wired for complete metallic circuits.

It is best, by all means, to have all the exchange apparatus and circuits wired for complete metallic circuits, even if a common wire or ground-return system is used for the outside line circuits. Complete metallic line circuits are by far the most satisfactory, and ground-return systems give the most trouble from cross talk, induction, and leakage through them of trolley and other currents. Where there are trolley systems or where they are apt to be installed in the near future, ground-return telephone systems should not be installed. If it can be afforded, a complete metallic system should be installed by all means, and if resort must be had to a cheaper system, a common-return wire should be used in preference to a ground return.

The common-return should be a copper wire and not smaller than No. 8 B. & S. gauge. The more telephones there are connected to one common-return wire, and the longer the common-return wire, the larger it should be. However, it is rarely necessary to make it larger than No. 6 B. & S. copper wire. The several common-return leads should all be connected together at the exchange, but nowhere else, and it is usually best not to ground the common-return anywhere.

In an exchange of small or moderate size the line circuits pass from the horizontal side of the distributing board in the form of neat cables to the switchboard itself. In large exchanges, which are not under consideration at this time, an intermediate distributing board is usually necessary. The object of the main distributing board is to enable changes to be readily made between the lines and the switchboard. For instance, if a subscriber moves he can still be allowed to retain his original number, because his new line can be readily connected by means of jumpers in the distributing board with its original jacks and annunciator on the switchboard, his old line, of course, being disconnected at the same time from the same jacks and annunciator. The old line can be used for a new subscriber, using, however, a different number for it.

The cables between the distributing board and switchboard consist, preferably, of No. 22 B & S. tinned-copper wire, insulated like ordinary annunciator wire, although it is much better to use a covering consisting of two layers of silk, outside of which is a single wrapping of cotton. Some Bell companies use for this purpose a tinned-copper wire covered with two wraps of wool and outside of that a braiding of wool. This wire is known as flame-proof, because it will not readily burn with a flame.

It is very important to have all the wiring in an exchange done in a systematic and neat manner. This is especially necessary in exchanges of any size, for otherwise the multitude of loose and tangled wires would make it very difficult to trace out circuits and to locate trouble by the ordinary tests, to say nothing of the unsightly appearance. Moreover, the absolute necessity of not wasting any space in the arrangement of a switchboard is a potent reason for systematically arranging the circuits.

INTERIOR WIRING.

DIRECT-CURRENT FEEDERS AND MAINS.

The simplest case of interior wiring is that of the minor customer who has a very few lamps in a very small space. In such a case it is merely a matter of running a single pair of wires from the entrance cut-out to the lamps, as in Fig. 1. For such an installation it is usually not necessary to figure the size of wire to be used; the smallest size permitted by the underwriters' rules will do. Table I herewith gives the carrying capacities of the standard sizes of wire. The capacities in amperes are those specified by the National Board of Fire Underwriters; the equivalents in lamps were deduced by the writer from the current values.

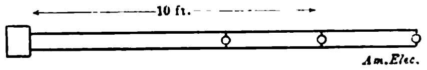


FIG. 1.—SIMPLE CIRCUIT.

As soon as the size of installation goes beyond half a dozen 110-volt lamps, however, or the center of distribution is an abnormal distance from the supply circuit (or the transformer, as the case may be), then it becomes expedient to divide the wiring into two distinct elements—

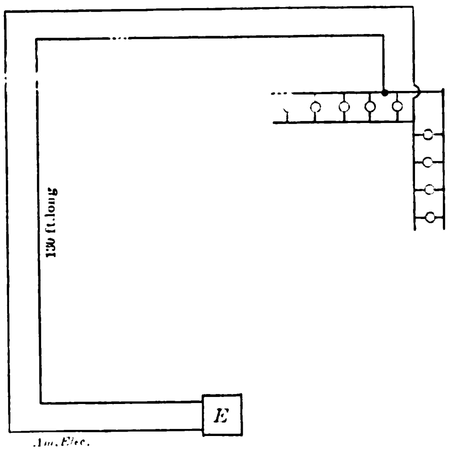


FIG. 2.—UNUSUALLY LONG FEEDER.

a feeder and one or more mains. Fig. 2 represents such a case; the lights were in a back room and could not be reached by a more direct route than that indicated. In this case, the "main" was No. 14, the smallest allowable size, the area of distribution being so compact and the lights so few; the feeder, however, had to be No. 12 in order to avoid excessive drop. This, of course, is an unusual case.

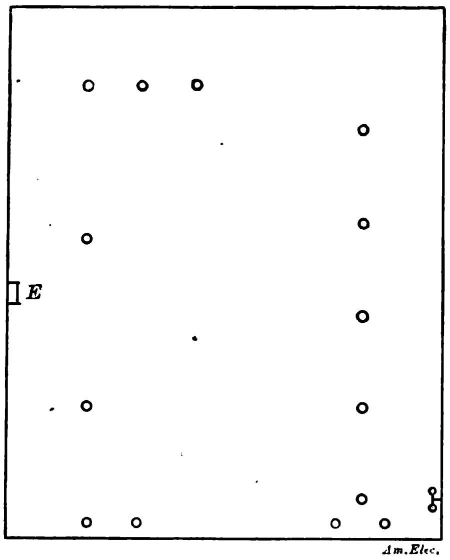


FIG. 3.—POSITION OF LIGHTS.

The converse of this case is indicated by Fig. 3, where the distance from the distributive center to the entrance block is short, but the distribution is less compact. Cases of this kind, when exposed wiring is used, are almost invariably disposed of by the use of a general main through the center of the lay-out, from which "taps" lead over to the lamps as in Fig. 4. When this arrangement is employed the taps should be of such a size that the drop in them is very small. A convenient table for application to such taps is Table II, contributed to the October number by Mr. Geo. W. Malcolm and reprinted herewith. Although the table is referred to as giving negligible drop, the amount of drop for which it was computed, according to the author, is ¼ volt for a 110-volt system, or practically ¼ of 1 per cent. Consequently, in applying the table it will be advisable to deduct ¼ of 1 per cent from the total drop desired and figure the remainder of the wiring for the difference.

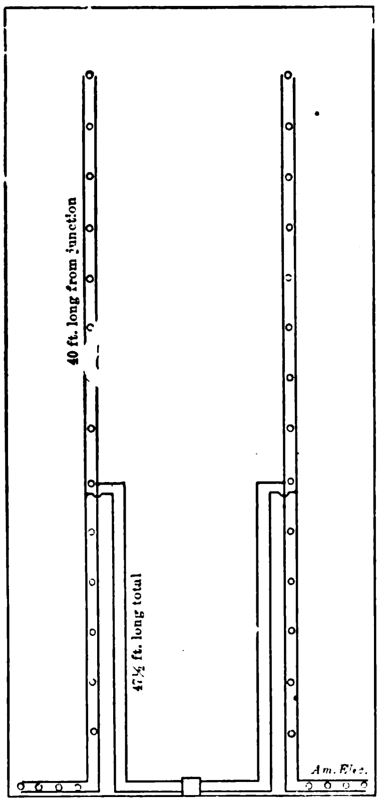


FIG. 6.—EXPOSED STORE WIRING.

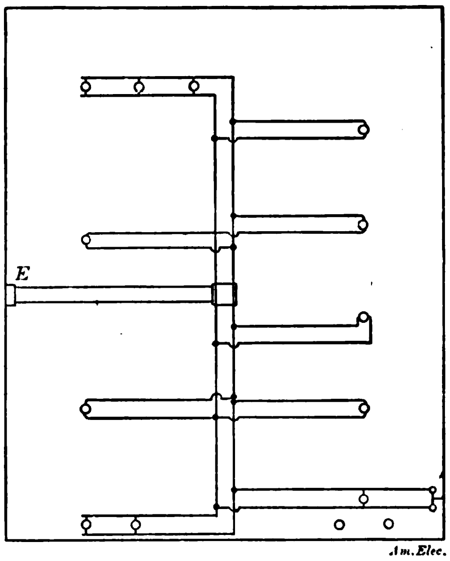


FIG. 4.—CENTRAL MAIN AND TAPS.

If the wiring for the case in Fig. 3 is to be concealed, the central main with taps, as shown in Fig. 4, may be used, but in this case the taps should be of the same size wire as the main in order to avoid a multiplicity of cut-out pockets, the taps terminating at exposed ceiling blocks. With a considerable number of lamps a better procedure for concealed distribution would be to put in two or more mains, each following the straightest line that will "pick up" a number of outlets in succession, as indicated in Fig. 5. The choice between these two arrangements will depend ordinarily upon the number of lamps and the area of distribution, the central main being preferable up to the point where the size of wire becomes unwieldy, and unless it is imperative to subdivide circuits for switching purposes.

In all of the foregoing cases the size of wire for each feeder and main usually has to be computed separately, in order that a predetermined limit in drop may not be exceeded. In order to reduce the amount of labor necessary to ascertain the proper sizes of wire to be used, Table III has been prepared. This is a formidable array of figures, at first glance, but it is a tremendous labor saver, the sizes of a feeder and a main being given by it in a single operation. The table is used as follows:

Assume temporarily a size of wire amply large for the feeder; find the column headed by this size of wire, and follow it downward to the number that is nearest the number of lamp-feet in the feeder; trace to the right along the line containing this number until the column headed by the total drop is reached. In this column a reference letter will be found, unless the assumed size of feeder wire is too small; find the same reference letter in the left-hand column of the table, and trace from it horizontally into the body of the table until the number nearest the lamp-feet of the *main* is reached; at the head of the column containing this number will be found the size of wire for the main. When the numbers in the body of the table differ from the lamp-feet of the feeder or main, it will usually be found advisable to take the nearest *smaller* number for the feeder

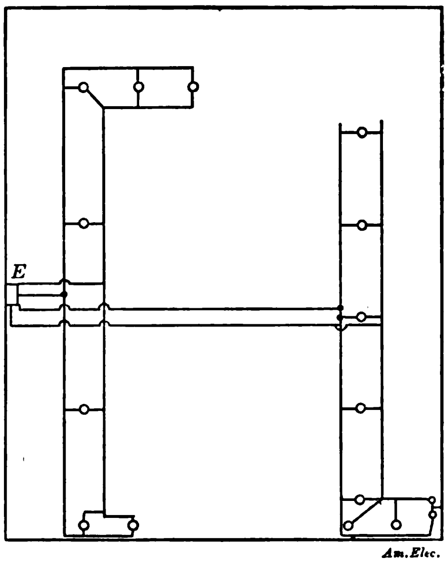


FIG. 5.—TWO-MAIN DISTRIBUTION.

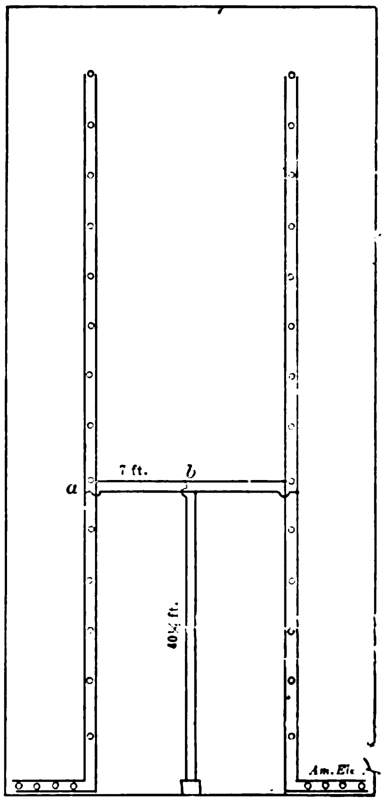


FIG. 7.—BRIDGED MAINS

lamp-feet and the nearest *larger* number for the lamp-feet of the main.

TABLE I.—CARRYING CAPACITY OF INSULATED WIRES.

Size of wire.	Rubber Covered Wires.					Weatherproof Insulation.				
	110-volt lamps.		115-volt lamps.			110-volt lamps.		115-volt lamps.		
	3.1 watt.	3½ watt.	3.1 watt.	3½ watt.	Amperes.	3.1 watt.	3½ watt.	3.1 watt.	3½ watt.	Amperes.
0000	465½	412½	487	431	210	692	613	723	640½	312
000	392½	347½	410	363	177	581	514½	607½	538	262
00	332½	294½	347½	308	150	488	432	510	451½	220
0	281½	249½	294½	260½	127	410	363½	429	380	185
1	237	210	248	219½	107	346	306½	361½	320	156
2	199½	176½	208½	184½	90	290½	257	303½	269	131
3	168½	149	176	156	76	244	216	255	225½	110
4	144	127½	150½	133½	65	204	180½	213	188½	92
5	119½	106	125	110½	54	170½	151	178½	158	77
6	102	90	106½	94	46	144	127½	150½	133½	65
8	73	64½	76½	67½	33	102	90	106½	94	46
10	53	47	55½	49	24	70½	62½	74	65½	32
12	37½	33	39	34½	17	51	45	53	47	23
14	26½	23½	27½	24½	12	35½	31	37	32½	16
16	13	11½	13½	12	6	17½	15½	18½	16	8
18	6½	5½	6	6	3	11½	9½	11½	10	5

The capacity in lamps is reckoned in 16-c. p. units, the fractions applying to cases involving also an odd number of 24-c. p. lamps.

For example, suppose one has a simple case of exposed store wiring like that shown in Fig. 6, and the drop limit is 1½ per cent. As the two sides are symmetrical, only one need be computed. The feeder is 47½ feet long and the distributing main is 40 feet long each way from the junction. The feeder supplies 18 lamps, so that it has 18 × 47½ = 855 lamp-feet. Each half of the main carries 9 lamps and the length from the junction to the center of the string of lamps is 20 feet, giving 20 × 9 = 180 lamp-feet to each half of the main. Table I shows that No. 14 wire will carry the 18 lamps with a liberal margin of safety, so this may be assumed as the preliminary size for the feeder. Following down the No. 14 column of **Table III, the nearest** number of lamp-feet is 852; tracing from this over to 1½ per cent column, a blank is found, which indicates that the size assumed for the feeder was too small.

Starting over again, this time in No. 12 column, the exact number of lamp-feet, 855, is found not quite halfway down the column. Tracing horizontally to the right, in the 1½ per cent column the reference letter **B** is found. Now, from this same letter in the extreme left-hand column of the table trace horizontally until the number nearest the lamp-feet of the main is found; this number is 189, and at the top of the column containing it is "10 & 12," meaning that one wire of the main should be No. 10 and the other No. 12. If one does not care for a very close approximation to the specified drop of 1½ per cent, No. 10 may be used, in which case the drop will be a little less; or using No. 12, the drop will be a little more than intended.

In a case such as that indicated in Fig. 6, it would usually be found preferable to join the two lines of distributing mains by a "bridge," and use only one feeder delivering to the center of the bridge, as shown in Fig. 7. With this arrangement, that part of the "bridge" from the junction *a* to the junction *b* may be considered as a part of the feeder and figured in with it. Thus, each half of the "bridge" is 7 feet long and supplies 18 lamps, which makes 7 × 18 = 126 lamp-feet; the feeder in this case has 40 × 36 = 1440 lamp-feet, making the total feeder lamp-feet 1566. As the feeder supplies 36 lamps the wire cannot be smaller than No. 12 if weatherproof, or No. 10 if rubber-covered. The mains have each 180 lamp-feet, as before. Table III shows that any of the following combinations may be used:

Feeder. 1566 lamp-feet.	Mains. 180 lamp-feet.
No. 10	No. 2
No. 9	Nos. 12 & 14
No. 8	No. 14

It is preferable in cases of this kind to put most of the drop in the feeder, so that the drop in voltage from the lamp nearest the junction to the one farthest away will be imperceptible; moreover, it is mechanically preferable to use as small wires as possible. So, in the above case the choice would naturally be for No. 9 wire in the feeder and either No. 12 or Nos. 12 and 14 in the mains.

Still another method of treating the somewhat unusual case of Fig. 7 is to apply Table II to the bridge wire and Table III to the feeder and mains. The drop for which Table II is computed being practically ¼ of 1 per cent, this should be deducted from the desired total drop of 1½ per cent, leaving 1¼ per cent as the "total drop" to be considered in using Table III. Table II shows that No. 12 wire will carry 18 lamps 8½ feet at the drop assumed by the table, and this, therefore, will be the size for the bridge. Table III then gives the following combinations for the feeder and mains:

Feeder. 1458 lamp-feet.	Mains. 180 lamp-feet.
No. 9	No. 10
No. 8	Nos. 12 & 14
No. 7	No. 14

The foregoing method of usage may, of course, be reversed, and the operation started by assuming a size for the main and ascertaining the size of feeder necessary to be used with it for a given total drop. The most expeditious method, however, is usually that outlined above. The wires can also be treated individually. The size of wire to be used for a main or feeder alone, at a given drop, is found by tracing to the left from 0 in the drop column to the number nearest the lamp-feet; at the head of the column containing this number will be found the size of wire. Thus, in Fig. 2 there is a feeder 130 ft. long, supplying 9 lamps; the number of lamp-feet, therefore, is 1170. Suppose the total drop desired were 2 per cent and the drop in the main were ¼ of 1 per cent; then the feeder would have to have 1¾ per cent drop. In the 1¾ per cent column find 0, and trace from it horizontally until the nearest number to 1170 is found; this is 1168, and the wire size at the head of that column is No. 12.

TABLE II.—GIVING CAPACITIES OF LINE WIRES AT NEGLIGIBLE DROP.

3½ watt lamps.		Wire Sizes; B. & S. Gauge: No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 12	No. 14
110 v.	220 v.	Distance in Feet:								
1	4	968	768	608	482	382	303	240	151	95
1½	6	645	511	405	321	255	202	160	101	63
2	8	482	383	303	240	191	151	120	75	47
2½	10	387	307	243	193	153	121	96	60	38
3	12	322	255	202	160	127	101	80	50	32
3½	14	276	219	173	137	109	86	69	43	27
4	16	242	192	152	120	95	76	60	38	23
4½	18	215	170	135	107	85	67	53	33	21
5	20	193	153	122	96	76	60	48	30	19
5½	22	176	139	110	87	69	55	44	27	17
6	24	161	128	101	80	64	50	40	25	16
6½	26	149	118	93	74	59	47	37	23	14
7	28	138	109	87	69	54	43	34	21	13
7½	30	129	102	81	64	51	40	32	20	12½
8	32	121	96	76	60	48	38	30	19	12
8½	34	114	90	71	57	45	35	28	18	11
9	36	107	85	67	53	42	33	26	17	10½
9½	38	102	81	64	51	40	32	25	16	10
10	40	97	77	61	48	38	30	24	15	9½
10½	42	92	73	58	46	36	29	23	14¼	9
11	44	88	70	55	44	35	27	22	13½	8⅔
11½	46	84	66	53	42	33	26	21	13	8⅓
12	48	80	64	50	40	32	25	20	12½	8
12½	50	77	61	48	38	30	24	19	12	7⅔
13	52	74	59	47	37	29	23	18½	11½	7⅓
13½	54	71	57	45	35	28	22	18	11	7
14	56	69	55	43	34	27	21½	17	10⅔	6¾
14½	58	66	53	42	33	26	21	16½	10⅓	6½
15	60	64	51	40	32	25	20	16	10	6¼
15½	62	62	49	39	31	24½	19½	15½	9½	6
16	64	60	48	38	30	24	19	15	9	5¾
17	68	57	45	36	28	22	18	14	9	5½
18	72	53	42	33	27	21	16½	13	8½	5¼
19	76	50	40	32	25	20	16	12½	8	5
20	80	48	38	30	24	19	15	12	7½	.....
21	84	46	36	29	23	18	14½	11½	7	.....
22	88	44	35	27	22	17½	13½	10⅔	6¾	.....
23	92	42	33	26	21	16½	13	10⅓	6½	.....
24	96	40	32	25	20	16	12½	10	6¼	.....
25	100	38	30	24	19	15	12	9½	6	.....

The application of the table to 220 volts is intended for the three-wire system, with 110-volt lamps, although it would apply to a 220-volt two-wire system if 3½-watt high-voltage lamps were obtainable.

The fractional numbers of lamps are to provide for 24-c.p. units.

TABLE III.—110-VOLT FEEDERS AND MAINS.

Numbers in the body of the table are lamp-feet (Lamps × Feet); based on 16-c.p. 3½-watt lamps.

	Wire sizes; B. & S. Gauge:																		Total drop in per cent. of lamp voltage.								
	0000	000	00	0	1	2	3	4	5	6	7	8	9	10	10 & 12	12	12 & 14	14	1	1¼	1½	1¾	2	2¼	2½	2¾	3
a	676	536	425	337	267	212	168	133	105	83	66	52	41	33	27	21	17	13	**H**	**J**	**M**	**P**	**R**	**T**	**V**	**X**	**Z**
A	1,352	1,072	850	674	535	424	336	266	211	167	133	105	83	66	54	41	34	26	*H*	*J*	*M*	*P*	*R*	*T*	*V*	*X*	*Z*
A	2,028	1,608	1,275	1,012	802	636	504	400	317	251	199	158	125	99	81	62	51	39	**h**	**j**	**m**	**p**	**r**	**t**	**v**	**x**	**z**
b	2,704	2,144	1,700	1,349	1,069	848	672	533	423	335	266	211	167	132	108	83	68	52	*h*	*j*	*m*	*p*	*r*	*t*	*v*	*x*	*z*
b	3,380	2,680	2,126	1,686	1,337	1,060	840	667	528	419	332	263	209	165	135	104	85	65	**G**	**I**	**K**	**N**	**Q**	**S**	**U**	**W**	**Y**
B	4,056	3,216	2,521	2,024	1,604	1,272	1,009	800	634	503	399	316	251	199	162	125	102	78	*G*	*I*	*K*	*N*	*Q*	*S*	*U*	*W*	*Y*
B	4,732	3,752	2,976	2,361	1,872	1,484	1,177	933	740	587	465	369	292	232	189	146	119	91	**g**	**i**	**k**	**n**	**q**	**s**	**u**	**w**	**y**
c	5,408	4,289	3,401	2,699	2,139	1,696	1,345	1,067	846	671	532	422	334	265	216	166	135	105	*g*	*i*	*k*	*n*	*q*	*s*	*u*	*w*	*y*
c	6,084	4,825	3,826	3,036	2,406	1,908	1,513	1,200	951	754	598	474	376	298	243	187	152	118	**F**	**H**	**J**	**M**	**P**	**R**	**T**	**V**	**X**
C	6,760	5,361	4,251	3,373	2,674	2,120	1,681	1,333	1,057	838	665	527	418	331	270	208	169	131	*F*	*H*	*J*	*M*	*P*	*R*	*T*	*V*	*X*
C	7,436	5,897	4,676	3,711	2,941	2,332	1,849	1,467	1,163	922	731	580	460	364	297	229	186	144	**f**	**h**	**j**	**m**	**p**	**r**	**t**	**v**	**x**
d	8,112	6,433	5,102	4,048	3,208	2,544	2,017	1,600	1,269	1,006	797	633	502	398	324	250	203	157	*f*	*h*	*j*	*m*	*p*	*r*	*t*	*v*	*x*
d	8,788	6,969	5,527	4,385	3,476	2,756	2,186	1,734	1,374	1,090	864	685	543	431	351	271	220	170	**E**	**G**	**I**	**K**	**N**	**Q**	**S**	**U**	**W**
D	9,464	7,505	5,952	4,723	3,743	2,968	2,354	1,867	1,480	1,174	930	738	585	464	378	292	237	183	*E*	*G*	*I*	*K*	*N*	*Q*	*S*	*U*	*W*
D	10,140	8,042	6,378	5,060	4,011	3,181	2,522	2,000	1,586	1,258	997	791	627	497	405	313	254	196	**e**	**g**	**i**	**k**	**n**	**q**	**s**	**u**	**w**
e	10,815	8,578	6,802	5,398	4,278	3,393	2,690	2,134	1,692	1,342	1,063	844	669	530	432	333	271	210	*e*	*g*	*i*	*k*	*n*	*q*	*s*	*u*	*w*
e	11,490	9,114	6,228	5,735	4,545	3,605	2,858	2,267	1,797	1,425	1,130	896	711	563	459	354	288	223	**D**	**F**	**H**	**J**	**M**	**P**	**R**	**T**	**V**
E	12,170	9,650	7,653	6,072	4,813	3,817	3,026	2,400	1,903	1,509	1,196	949	753	597	486	375	305	236	*D*	*F*	*H*	*J*	*M*	*P*	*R*	*T*	*V*
E	12,845	10,185	8,078	6,410	5,080	4,029	3,195	2,534	2,009	1,593	1,263	1,002	795	630	513	396	322	249	**d**	**f**	**h**	**j**	**m**	**p**	**r**	**t**	**v**
f	13,520	10,720	8,503	6,747	5,348	4,241	3,363	2,667	2,115	1,677	1,329	1,055	836	663	540	417	339	262	*d*	*f*	*h*	*j*	*m*	*p*	*r*	*t*	*v*
f	14,195	11,258	8,928	7,084	5,615	4,453	3,531	2,801	2,220	1,761	1,396	1,107	878	696	557	438	356	275	**C**	**E**	**G**	**I**	**K**	**N**	**Q**	**S**	**U**
F	14,870	11,795	9,353	7,422	5,883	4,665	3,699	2,934	2,326	1,845	1,462	1,160	920	729	594	459	373	288	*C*	*E*	*G*	*I*	*K*	*N*	*Q*	*S*	*U*
F	15,550	12,330	9,779	7,759	6,150	4,877	3,867	3,067	2,432	1,929	1,529	1,213	962	762	621	480	390	301	**c**	**e**	**g**	**i**	**k**	**n**	**q**	**s**	**u**
g	16,225	12,866	10,205	8,096	6,417	5,089	4,035	3,201	2,538	2,012	1,595	1,266	1,004	796	648	500	407	314	*c*	*e*	*g*	*i*	*k*	*n*	*q*	*s*	*u*
g	16,900	13,402	10,630	8,434	6,685	5,301	4,203	3,334	2,643	2,096	1,662	1,318	1,046	829	675	521	424	328	**B**	**D**	**F**	**H**	**J**	**M**	**P**	**R**	**T**
G	17,575	13,940	11,055	8,771	6,952	5,513	4,372	3,468	2,749	2,180	1,728	1,371	1,087	862	702	542	441	341	*B*	*D*	*F*	*H*	*J*	*M*	*P*	*R*	*T*
G	18,250	14,475	11,480	9,109	7,219	5,725	4,540	3,601	2,855	2,264	1,795	1,424	1,129	895	729	563	458	354	**b**	**d**	**f**	**h**	**j**	**m**	**p**	**r**	**t**
h	18,930	15,010	11,905	9,446	7,487	5,937	4,708	3,734	2,961	2,348	1,861	1,477	1,171	928	756	584	475	367	*b*	*d*	*f*	*h*	*j*	*m*	*p*	*r*	*t*
h	19,605	15,545	12,330	9,783	7,754	6,150	4,876	3,868	3,066	2,432	1,928	1,529	1,213	961	783	605	492	380	**A**	**C**	**E**	**G**	**I**	**K**	**N**	**Q**	**S**
H	20,280	16,085	12,755	10,120	8,022	6,362	5,045	4,001	3,172	2,516	1,994	1,582	1,255	995	810	626	509	393	*A*	*C*	*E*	*G*	*I*	*K*	*N*	*Q*	*S*
H	20,955	16,620	13,180	10,457	8,289	6,574	5,212	4,135	3,278	2,600	2,061	1,635	1,297	1,028	837	646	526	406	**a**	**c**	**e**	**g**	**i**	**k**	**n**	**q**	**s**
i	21,630	17,155	13,605	10,795	8,556	6,786	5,381	4,268	3,384	2,684	2,127	1,688	1,338	1,061	864	667	543	419	0	*c*	*e*	*g*	*i*	*k*	*n*	*q*	*s*
i	22,305	17,690	14,030	11,133	8,824	6,998	5,549	4,401	3,490	2,767	2,194	1,740	1,380	1,094	891	688	560	433	..	**B**	**D**	**F**	**H**	**J**	**M**	**P**	**R**
I	22,985	18,225	14,455	11,470	9,091	7,210	5,717	4,535	3,595	2,851	2,260	1,793	1,422	1,127	918	709	577	446	..	*B*	*D*	*F*	*H*	*J*	*M*	*P*	*R*
I	23,660	18,765	14,880	11,807	9,358	7,422	5,885	4,668	3,701	2,935	2,327	1,846	1,464	1,160	945	730	594	459	..	**b**	**d**	**f**	**h**	**j**	**m**	**p**	**r**
j	24,335	19,300	15,305	12,145	9,626	7,634	6,054	4,801	3,807	3,019	2,393	1,899	1,506	1,194	972	751	611	472	..	*b*	*d*	*f*	*h*	*j*	*m*	*p*	*r*
j	25,010	19,835	15,730	12,482	9,893	7,846	6,222	4,935	3,912	3,103	2,460	1,951	1,548	1,227	999	772	628	485	..	**A**	**C**	**E**	**G**	**I**	**K**	**N**	**Q**
J	25,685	20,360	16,155	12,820	10,160	8,058	6,390	5,068	4,018	3,187	2,526	2,004	1,590	1,260	1,026	792	645	498	..	*A*	*C*	*E*	*G*	*I*	*K*	*N*	*Q*
J	26,360	20,905	16,580	13,156	10,428	8,270	6,558	5,202	4,124	3,270	2,593	2,057	1,631	1,293	1,053	813	662	511	..	**a**	**c**	**e**	**g**	**i**	**k**	**n**	**q**
k	27,040	21,445	17,005	13,494	10,695	8,482	6,726	5,335	4,230	3,354	2,659	2,110	1,673	1,326	1,080	834	679	524	..	0	*c*	*e*	*g*	*i*	*k*	*n*	*q*
k	27,715	21,980	17,430	13,830	10,963	8,694	6,894	5,468	4,335	3,438	2,726	2,162	1,715	1,360	1,107	855	696	537	..	..	**B**	**D**	**F**	**H**	**J**	**M**	**P**
K	28,390	22,515	17,855	14,170	11,230	8,906	7,062	5,602	4,441	3,522	2,792	2,215	1,757	1,393	1,134	876	713	551	..	..	*B*	*D*	*F*	*H*	*J*	*M*	*P*
K	29,070	23,050	18,280	14,505	11,498	9,118	7,230	5,735	4,547	3,606	2,858	2,268	1,798	1,426	1,161	897	730	564	..	..	**b**	**d**	**f**	**h**	**j**	**m**	**p**
m	29,740	23,590	18,705	14,843	11,765	9,330	7,398	5,868	4,653	3,690	2,925	2,321	1,840	1,459	1,188	918	747	577	..	..	*b*	*d*	*f*	*h*	*j*	*m*	*p*
m	30,420	24,125	19,130	15,180	12,033	9,542	7,567	6,002	4,758	3,774	2,992	2,373	1,882	1,492	1,215	938	764	590	..	..	**A**	**C**	**E**	**G**	**I**	**K**	**N**
M	31,095	24,660	19,555	15,518	12,300	9,754	7,735	6,135	4,864	3,858	3,058	2,426	1,924	1,525	1,242	959	781	603	..	..	*A*	*C*	*E*	*G*	*I*	*K*	*N*
M	31,770	25,195	19,980	15,855	12,566	9,966	7,903	6,269	4,970	3,942	3,125	2,479	1,966	1,558	1,270	980	798	616	..	..	**a**	**c**	**e**	**g**	**i**	**k**	**n**
n	32,445	25,730	20,405	16,193	12,834	10,178	8,071	6,402	5,076	4,025	3,191	2,532	2,008	1,592	1,296	1,000	815	629	..	..	0	*c*	*e*	*g*	*i*	*k*	*n*
n	33,120	26,270	20,830	16,530	13,100	10,390	8,239	6,535	5,181	4,109	3,257	2,585	2,050	1,625	1,323	1,022	832	642	..	..	..	**B**	**D**	**F**	**H**	**J**	**M**
N	33,800	26,805	21,260	16,866	13,370	10,602	8,407	6,668	5,287	4,193	3,324	2,637	2,092	1,658	1,350	1,043	849	656	..	..	..	*B*	*D*	*F*	*H*	*J*	**M**
N	34,475	27,340	21,680	17,205	13,636	10,815	8,575	6,802	5,393	4,277	3,390	2,690	2,133	1,691	1,377	1,064	866	669	..	..	..	**b**	**d**	**f**	**h**	**j**	**m**
p	35,150	27,875	22,110	17,540	13,904	11,027	8,744	6,935	5,499	4,361	3,457	2,743	2,175	1,724	1,404	1,085	883	682	.		..	*b*	*d*	*f*	*h*	*j*	*m*
p	35,825	28,415	22,530	17,880	14,170	11,239	8,912	7,069	5,604	4,445	3,523	2,796	2,217	1,757	1,431	1,105	900	695	.	..	..	**A**	**C**	**E**	**G**	**I**	**K**
P	36,500	28,950	22,960	18,215	14,438	11,450	9,080	7,202	5,710	4,529	3,590	2,848	2,259	1,790	1,458	1,126	917	708	..	.	..	*A*	*C*	*E*	*G*	*I*	*K*
P	37,175	29,485	23,380	18,555	14,706	11,663	9,248	7,336	5,816	4,612	3,656	2,901	2,300	1,824	1,485	1,147	934	721	.	..	..	**a**	**c**	**e**	**g**	**i**	**k**
q	37,855	30,020	23,810	18,890	14,974	11,875	9,416	7,469	5,922	4,696	3,723	2,954	2,342	1,857	1,512	1,168	951	734	..	..	..	0	*c*	*e*	*g*	*i*	*k*
q	38,530	30,555	24,230	19,230	15,240	12,087	9,584	7,602	6,028	4,780	3,789	3,006	2,384	1,890	1,540	1,189	968	747	.	.	..	..	**B**	**D**	**F**	**H**	**J**
Q	39,205	31,095	24,660	19,565	15,509	12,300	9,752	7,736	6,133	4,864	3,856	3,059	2,426	1,923	1,566	1,210	985	761	.	.	..	..	*B*	*D*	*F*	*H*	*J*
Q	39,885	31,630	25,085	19,905	15,775	12,510	9,921	7,869	6,239	4,948	3,922	3,112	2,468	1,956	1,593	1,230	1,002	774	..	..	..	..	**b**	**d**	**f**	**h**	**j**
r	40,560	32,165	25,510	20,240	16,043	12,725	10,090	8,002	6,345	5,032	3,989	3,165	2,510	1,990	1,620	1,251	1,019	787	..	..	.	..	*b*	*d*	*f*	*h*	*j*
r	41,235	32,700	25,935	20,575	16,300	12,935	10,257	8,126	6,450	5,116	4,055	3,217	2,552	2,023	1,647	1,272	1,036	800	..	..	..	..	**A**	**C**	**E**	**G**	**I**
R	41,910	33,240	26,360	20,915	16,577	13,145	10,425	8,269	6,556	5,200	4,122	3,270	2,593	2,056	1,674	1,293	1,053	813	..	..	..	..	*A*	*C*	*E*	*G*	*I*
R	42,585	33,775	26,785	21,250	16,845	13,360	10,593	8,402	6,662	5,283	4,188	3,323	2,635	2,089	1,702	1,314	1,070	826	..	..	..	..	**a**	**c**	**e**	**g**	**i**
s	43,265	34,310	27,210	21,590	17,113	13,570	10,762	8,536	6,768	5,367	4,255	3,376	2,677	2,122	1,729	1,335	1,087	839	..	..	..	..	0	*c*	*e*	*g*	*i*
s	43,940	34,845	27,635	21,925	17,380	13,783	10,930	8,669	6,873	5,451	4,321	3,428	2,719	2,155	1,756	1,356	1,104	852	..	..	..	..	..	**B**	**D**	**F**	**H**
S	44,615	35,380	28,060	22,265	17,648	13,995	11,098	8,803	6,979	5,535	4,388	3,481	2,761	2,188	1,783	1,377	1,121	865	..	..	..	..	..	*B*	*D*	*F*	*H*
S	45,290	35,920	28,485	22,600	17,915	14,208	11,265	8,936	7,085	5,619	4,454	3,534	2,803	2,222	1,810	1,397	1,138	879	..	..	..	..	..	**b**	**d**	**f**	**h**
t	45,965	36,455	28,910	22,940	18,180	14,420	11,434	9,069	7,191	5,703	4,521	3,587	2,844	2,255	1,836	1,418	1,155	892	..	..	..	..	..	*b*	*d*	*f*	*h*
t	46,640	36,990	29,335	23,275	18,450	14,630	11,602	9,203	7,296	5,787	4,587	3,640	2,886	2,288	1,864	1,439	1,172	905	..	..	..	..	..	**A**	**C**	**E**	**G**
T	47,320	37,525	29,760	23,615	18,715	14,844	11,770	9,336	7,402	5,870	4,654	3,692	2,928	2,321	1,891	1,460	1,189	918	..	..	..	..	..	*A*	*C*	*E*	*G*
T	47,995	38,065	30,185	23,950	18,985	15,055	11,938	9,470	7,508	5,954	4,720	3,745	2,970	2,354	1,918	1,481	1,206	931	.	..	..	..	..	**a**	**c**	**e**	**g**
u	48,670	38,600	30,620	24,290	19,250	15,265	12,107	9,603	7,614	6,038	4,787	3,798	3,012	2,387	1,945	1,502	1,223	944	..	..	..	..	..	0	*c*	*e*	*g*
u	49,345	39,135	31,035	24,625	19,520	15,480	12,275	9,736	7,719	6,122	4,853	3,850	3,054	2,421	1,972	1,523	1,240	957	..	..		..	..	..	**B**	**D**	**F**
U	50,020	39,670	31,460	24,960	19,785	15,690	12,443	9,870	7,825	6,206	4,920	3,903	3,095	2,454	1,999	1,543	1,257	970	..	..	..	..	.	..	*B*	*D*	*F*
U	50,700	40,210	31,885	25,300	20,055	15,905	12,610	10,003	7,931	6,290	4,986	3,956	3,137	2,487	2,026	1,564	1,274	984	..	..	..	..	..	..	**b**	**d**	**f**
v	51,375	40,745	32,310	25,635	20,320	16,115	12,780	10,135	8,036	6,374	5,052	4,009	3,179	2,520	2,053	1,585	1,291	997	..	..	..	..	..	..	*b*	*d*	*f*
v	52,050	41,280	32,735	25,975	20,590	16,325	12,948	10,270	8,142	6,458	5,119	4,062	3,221	2,553	2,080	1,606	1,308	1,010	..	..	..	..	..	..	**A**	**C**	**E**
V	52,725	41,815	33,160	26,310	20,855	16,530	13,115	10,403	8,248	6,541	5,186	4,114	3,263	2,587	2,107	1,627	1,325	1,023	..	..	..	..	..	..	*A*	*C*	*E*
V	53,400	42,350	33,585	26,650	21,123	16,750	13,284	10,537	8,354	6,625	5,252	4,167	3,305	2,620	2,134	1,648	1,342	1,036	..	..	.	..	..	..	**a**	**c**	**e**
w	54,080	42,890	34,010	26,985	21,390	16,965	13,450	10,670	8,460	6,709	5,319	4,220	3,346	2,653	2,161	1,669	1,359	1,049	..	..	..	..	..	..	0	*c*	*e*
w	54,755	43,425	34,435	27,325	21,660	17,175	13,620	10,804	8,565	6,793	5,385	4,272	3,388	2,686	2,188	1,690	1,376	1,062	..	..	..	..	..	..	..	**B**	**D**
W	55,430	43,960	34,860	27,660	21,925	17,388	13,788	10,938	8,671	6,877	5,452	4,325	3,430	2,719	2,215	1,710	1,393	1,075	..	..	..	..	..	..	..	*B*	*D*
W	56,110	44,495	35,285	28,000	22,190	17,600	13,956	11,070	8,777	6,961	5,518	4,378	3,472	2,752	2,242	1,731	1,410	1,088	..	..	..	..	..	..	..	**b**	**d**
x	56,785	45,035	35,715	28,335	22,460	17,813	14,125	11,204	8,882	7,045	5,585	4,431	3,514	2,785	2,269	1,752	1,427	1,102	..	.	..	..	..	..	..	*b*	*d*
x	57,460	45,570	36,140	28,675	22,725	18,025	14,292	11,337	8,988	7,129	5,651	4,483	3,556	2,819	2,296	1,773	1,444	1,115	..	..	..	..	..	..	..	**A**	**C**
X	58,135	46,105	36,560	29,010	22,995	18,235	14,460	11,470	9,094	7,212	5,717	4,536	3,597	2,852	2,323	1,794	1,461	1,128	..	..	..	..	..	..	..	*A*	*C*
X	58,810	46,640	36,985	29,350	23,260	18,448	14,629	11,604	9,200	7,296	5,784	4,589	3,640	2,885	2,350	1,815	1,478	1,141	..	..	..	.	..	..	..	**a**	**c**
y	59,485	47,175	37,415	29,685	23,530	18,660	14,798	11,738	9,306	7,380	5,850	4,642	3,681	2,918	2,377	1,836	1,495	1,154	..	..	..	..	..	..	..	0	*c*
y	60,160	47,715	37,840	30,033	23,800	18,873	14,965	11,870	9,412	7,464	5,917	4,695	3,723	2,951	2,404	1,856	1,517	1,167	..	..	..	..	..	..	..	..	**B**
Y	60,840	48,250	38,265	30,360	24,065	19,085	15,133	12,004	9,517	7,548	5,984	4,747	3,765	2,984	2,431	1,877	1,529	1,180	..	..	..	..	..	..	..	..	*B*
Y	61,515	48,785	38,690	30,700	24,330	19,295	15,300	12,138	9,623	7,632	6,050	4,800	3,807	3,017	2,458	1,898	1,546	1,193	..	..	..	..	..	..	..	..	**b**
z	62,190	49,320	39,115	31,035	24,600	19,510	15,470	12,270	9,728	7,716	6,117	4,853	3,849	3,051	2,485	1,919	1,563	1,207	..	..	..	..	..	.	..	..	*b*
z	62,865	49,860	39,540	31,370	24,865	19,720	15,638	12,404	9,834	7,800	6,183	4,905	3,890	3,084	2,512	1,940	1,580	1,220	..	..	..	..	..	..	..	..	**A**
Z	63,545	50,395	39,965	31,710	25,135	19,933	15,806	12,538	9,940	7,884	6,250	4,958	3,933	3,117	2,539	1,961	1,597	1,233	..	..		..	..	..	..	..	*A*
Z	64,220	50,930	40,390	32,045	25,400	20,145	15,974	12,670	10,045	7,967	6,316	5,011	3,974	3,150	2,566	1,982	1,614	1,246	..	..	..	..	..	..	..	..	**a**

SOME BRUSH ARC-LIGHT DYNAMO TROUBLES AND THEIR REMEDIES.

BY F. B. O'HANLON.

Considering the number of years since its introduction it is somewhat surprising that no machine has been designed to satisfactorily take the place of the old Brush open-coil series arc lighter. True, there are other machines built which are giving considerable satisfaction, and which have been and are used to a large extent, yet the fact remains that for hard wear and tear and severe usage this old machine, designed in the early days of electric lighting, has not been surpassed nor, indeed, equaled. A number of improvements suggested by experience and modern requirements have, of course, been made; but as it stands to-day the machine is practically unchanged.

Some experiences of the writer's may be of use to many men who have these machines and their circuits under their charge. The greatest trouble of a new hand is in the trimming and setting of the brushes. This is just the point where a little knowledge would save an infinite amount of trouble and expense. The man has previously had a reasonable amount of experience with closed-coil armatures and their commutators and brushes, so he sets to work with the idea that his experience will hold good here. He gets a nice bevel on his brushes, and sets them to bear on the commutator with a good firm contact; then on starting up he finds that the brushes splutter and burn badly, so he puts more tension on, but only succeeds in scoring the commutator and perhaps breaking it down.

The brushes must not be trimmed with a bevel; they must be cut off quite square and have just the rough edge taken off with a file. In placing them in the holders they should be advanced until they touch the correct line on the commutator, then the brass backs should be moved up to within half an inch of the contact end of the brush.

Care should be taken when holding a brush in the vise that it is not pinched too tight near the end; this would cause the brush to be thinner at this point than further along, and so cause chattering as the open parts in the commutator passed under it. I remember one man who could not understand why his brushes spluttered so much, but who owed his entire trouble to carelessness in this respect. He had squeezed the brushes up so that the backs did not rest on them for part of their length, and this small clearance was quite sufficient to set up a vibration and so cause violent sparking.

Very little tension should be put on. It is quite sufficient if the brush does a little more than simply rest on the segment; more tension than this will sometimes be necessary to stop sparking, but this will only be when the brushes are short or the springs are weak. Very often sparking can be prevented by decreasing the tension on a brush.

The brushes will spark if they are too short. When this is the case no amount of alteration in the spring tension will improve them. There is a certain balanced springy effect which can only be supplied by a brush of medium length.

When a machine is at work and it is impossible to change a brush, a temporary remedy may be applied by inserting a piece of wood between the tail end of the brush and the holder; this has the effect of holding the brush against the commutator, but as it leads to excessive wear of both commutator and brush it should only be used as a last resource.

In speaking of the prevention of sparking I refer, of course, to the violent spluttering indicative of bad commutation. It is allowable and even necessary for sparks of a purple color, and about ⅛ to ⅝ in. long, to be produced, as the machine will flash over if it is attempted to run without them. These sparks are more of a static nature and do very little harm. They are a very useful indication of the condition of the armature, and a weak coil may be indicated by them a long time before it makes itself known in any other way.

If the armature is sound, one or two sparks of approximately equal length will show at each brush. But if one of the sparks is very short and the other on the same brush is about ⅝ in. long, and of a furry appearance, it is a certain indication of a weak coil. If the coil is very bad it will be much hotter than the others; but this is not to be taken as an indication that the armature is unfit for service. The writer has known machines to run for several weeks, although several layers were burnt quite bare in one coil.

Should a commutator break down, it can sometimes be got to run again by scraping out the burnt mica, or pending a more thorough repair, a coat of thin shellac varnish may be given. But a load should never be put on until the varnish is thoroughly dry.

Armatures will sometimes fail to generate owing to a failure of the insulation in the cross connections. These connections should never be finished off, as is sometimes done, with a millboard head. The writer has known a sleeve joint to give way and by setting fire to one of these heads cause the destruction of every coil in the armature.

Where the liquid type of regulator is used, reversing switches are provided in order to permit equalizing the wear of the carbons, and as these switches are designed with their contacts close together, so as not to open the circuit when the switch is thrown over, it follows that if the switch is left in the mid position the field will be short-circuited. In case of a failure to excite, this should be looked to.

If the machine flashes badly on starting up, it will probably be due to too strong a field, caused by a disconnection in the resistance of the regulator.

In case of a burn out in the coils of a regulator, the resistance may be coupled direct across the fields, and hand regulation used. To do this the two main leads should be disconnected from the regulator and coupled together; from this junction a lead should be taken to one terminal of the resistance, and from the other terminal of the resistance a connection should be made to the field terminal of the machine.

Grounds are troublesome, but these seldom occur on the machine. Regulators, however, are not free from them. In some regulators which came under the writer's notice, the relay solenoid had been shunted by a small wire resistance, the connections to which had been made with some common flux. This was all right as long as the flux remained clear of the case, but one eventually went to ground and caused considerable trouble before it was discovered.

With regard to faults on circuits, these are pretty well understood, but one case in the writer's experience is worthy of note. After a heavy rain a double ground developed on a circuit, cutting out a number of lamps. This was in a plant with underground mains, and as the fault could not then be removed, the circuit was allowed to run on. After a few hours' run, the circuit opened, and an insulation test showed that one side was grounded, the other being quite sound. This difficulty was got over by grounding one terminal of the dynamo and picking up the current about two miles from the station. Next day is was found that the cable had burned quite through, and so caused the open circuit.

THE CARE OF STREET-RAILWAY CONTROLLERS.

BY FRANK BERRY, JR.

The controllers of a street-railway car should be thoroughly inspected and cleaned at least once a week if the car is in regular service, as the cuttings and accumulations of dust are apt to cause a ground or short-circuit if they are allowed to collect for any length of time. The controller should be carefully watched for burnt spots on the contact segments and fingers. Any rough place due to burning should be smoothed with a file until the fingers rest squarely upon the contact strips. Any finger that does not make a firm contact should be lowered, unless the trouble is due to a weak spring or excessive wearing, in which case the finger should be immediately replaced by a new one.

If a controller has been inspected with a view to making sure that none of the contacts are broken earlier than they should be (which may be the case on account of excessive burning) the controller should be carefully cleaned with a cloth wherever the parts are accessible by this method, and a hand bellows should be used to blow the dust out of inaccessible places. In using the bellows, the connections at the base of the controller must not be overlooked, as an accumulation of dust there is liable to cause a break-down in the controller leads. Any metal lodged on the flash plates, which is due to arcing, should be scraped off.

After the controller has been cleaned and inspected a lubricant should be applied to the contact surfaces of the fingers in order to prevent mechanical cutting. The lubricant most commonly used is vaseline, although soft motor grease is sometimes used for this purpose. Whatever form of lubricant is used, it should be used sparingly, in order that the contact surfaces may not become gummed. The ratchet should also be lubricated, but more freely than the contact surfaces, in order that the cylinder may have a free movement.

When controllers are used with stops on the face plate, special attention should be given in order to make sure that the controller handles fit snugly on the shafts. The writer has seen controller handles in use which fitted so loosely, that upon moving the handle from the off position there was a free play of half an inch on the part of the handle before the drum began to move, and on the "loop" position some of the fingers which should have made contact scarcely touched, and were badly burned.

Lessons in Practical Electricity

MAGNETIZING POWER OF A COIL.

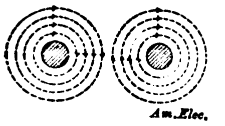


FIG. 1.

If two wires, side by side, carry equal currents in the same direction, the magnetic field set up in the space about the wires will be somewhat complex. Each wire will have its own field, but between the two wires the lines of forces set up by one wire will be opposite in direction to the lines about the other wire, as indicated in Fig. 1. Consequently at a point midway between the two wires, the lines of force from one wire will precisely balance the lines from the other wire, and the two sets of lines will unite and pass entirely around the two wires, the resulting field being about as shown in Fig. 2, where the two opposing sets of lines first unite at *a*. If the wires were brought so close together as to touch, the number of lines of force passing between them would be negligible, and the field set up by the currents in the two wires might be represented with a reasonable degree of accuracy as in Fig. 3.

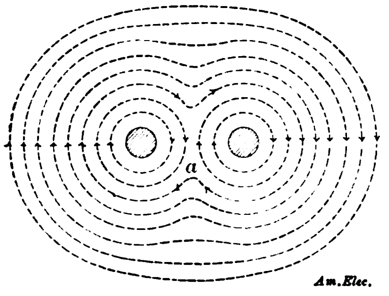


FIG. 2.—FIELD OF TWO PARALLEL WIRES.

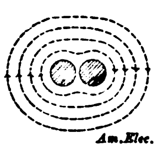


FIG. 3

Now, if a length of wire be coiled into ring shape and of several turns, the lines of force will encircle the several wires of the ring just as they did the ring of one turn, described in the preceding Lesson. And if the wires of the ring be side by side, forming a sort of tube, the lines of force will thread through this tube and close their individual circuits around the outside, as indicated roughly in Fig. 4. Such a coil is known as a "solenoid." If a view could be had of the magnetic lines through a solenoid in the central longitudinal plane, it would appear somewhat like Fig. 5, which represents a solenoid of 22 turns of wire cut in half endwise. The continuation of the lines of force threading the greater part of the hollow within the coil is omitted on account of space considerations. If drawn in with even an approach to accuracy, the diagram would more than cover this whole page.

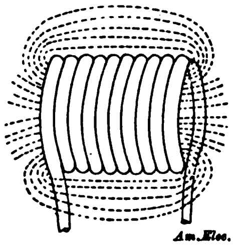


FIG. 4.—SOLENOID.

It is manifestly impractical to consider the magnetic forces at the various distances from the wire; in practice the total magnetizing power of the coil is considered. This magnetizing power is termed magnetomotive force, being the force that causes the magnetism to "flow." The analogy between this term and electromotive force will be at once apparent; magnetomotive force causes magnetism to "flow" and electromotive force causes electric current to "flow." The unit of magnetomotive force is the "gilbert," so named in honor of William Gilbert, an English physician and *savant*, who, in the sixteenth century, laid the foundation of modern electrical science.

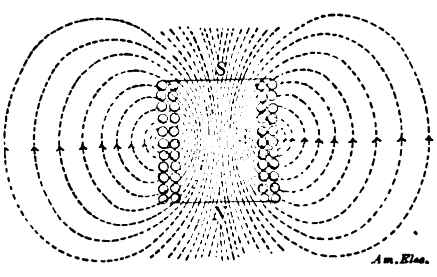


FIG. 5.—FIELD OF A SOLENOID.

The magnetizing power of a coil is proportional to the number of turns of wire and to the current in the wire. This will be evident upon reflection. A coil of 10 turns in series carrying 10 amperes will be precisely the same as a coil of 10 turns in parallel with 10 amperes in each turn; and the latter is exactly equivalent to a coil of one turn carrying 100 amperes, the conductor being of the same thickness as the wire in the other case, but ten times as wide. The product of turns and amperes is called ampere-turns, and the magnetomotive force of a coil is equivalent to its ampere-turns multiplied by 1.256637 (usually taken at 1.257).* For example, a coil of 100 turns through which 10 amperes flows would have a magnetizing power of 1000 ampere-turns, and this is equal to 1,256.637 gilberts. A coil of 500 turns carrying a current of 2 amperes would give precisely the same magnetomotive force.

As indicated roughly in Fig. 5, some of the lines of force leak out of the solenoid between the wires. On this account it is not possible to calculate accurately the strength of field set up by a coil at any particular point. The strength of field at the ends of the coil is just one-half the strength of field midway between the ends, for a solenoid of a length several times greater than its internal diameter. It is sufficiently accurate for ordinary engineering purposes, however, to ignore the leakage mentioned and consider the field uniform, in which case the total number of magnetic lines passing through the interior would be given by the formula

$$\Phi = \frac{C\ t \cdot A}{0.3133\ L} \quad \ldots\ldots\ldots\ldots (1)$$

in which *C* represents the current in amperes; *t*, the number of turns of wire in the coil; *A*, the area of the bore of the coil in square inches, and *L*, the length of the solenoid. This formula is based on the fact that the magnetic flux produced by the magnetomotive force of a coil varies inversely as the resistance of the path along which the lines are compelled to follow, just as a current of electricity does. And, as in the case of an electric conductor, the resistance of a magnetic conductor is proportional to its length and decreases as its transverse area increases. The unit of magnetic resistance, which is termed "reluctance," is the "oersted," having been named for Hans Christian Oersted, a professor

---

*The magnetic force at a point, *d* centimeters from the center of a straight wire carrying a current, *C*, is equal to $0.2\ C + d$, If a circle be drawn around the wire at the distance, *d*, from its center, the magnomotive force clear around the circular path will be equal to the magnetic force at a point in the path, multiplied by the length of the path measured in centimeters. The length of the path is evidently $2\pi d$, the distance, *d*, being the radius of a circle. Consequently, the magnetomotive force, *F*, around the whole circle will be

$$F = \frac{0.2\ C}{d} \times 2\pi d$$

which reduces to

$$F = 0.4\pi\ C = 1.256637\ C$$

This is for a single conductor. If there are *w* conductors side by side each carrying *C* amperes, the magnetomotive force will be *w* times as great, or

$$F = 1.256637\ C\ w,$$

irrespective of the shape into which the conductors are bent, so long as they are side by side.

at the University of Copenhagen, Denmark, who in 1820 made the discovery that a compass needle would be deflected by current passing in a wire nearby. No magnetic insulator has been thus far discovered; magnetic lines of force will pass through any known substance. All substances except a few minerals have a specific reluctance, or "reluctivity" of 1 oersted under the existing (C. G. S.) system of nomenclature; consequently the total reluctance of any magnetic path which does not include any of the excepted minerals is found by dividing the length of the path by its transverse area, using metric units; if English units are used, then the reluctance must be divided by 2.54. In other words, when figuring in English units, the specific reluctance of air or other non-magnetic substances may be considered as being $1 \div 2.54 = 0.3937$ oersted.

In the case of a solenoid, the length and area of only that portion of the path within the coil are considered, for the reason that as soon as the lines of force get beyond the ends of the coil they are no longer confined, and spread out over an infinite area; the reluctance of the path through which the lines complete their circuit outside of the coil is therefore considered to be zero, so that it is only the reluctance of the path within the coil that affects the field strength. Formula (1) may therefore be analyzed as follows: The magnetomotive force of the coil is $0.4 \pi C t$ gilberts; the reluctance of the path is $0.3937 L \div A$; the flux is equal to magnetomotive force ÷ reluctance, or

$$\Phi = \frac{1.25664 \text{ C t}}{0.3937 \text{ L} \div \text{A}}$$

which reduces to formula (1).

In most cases the density of the magnetic flux, or number of lines per square inch or square centimeter of path area within the solenoid is of more importance than the total number of lines. Still assuming no leakage, the density is obviously found by dividing the total number of lines by the transverse area of the path which they fill; thus,

$$\text{B} = \frac{\Phi}{\text{A}},$$

B representing the density or lines per square inch. Combining this with formula (1) gives the very simple expression

$$\text{B} = \frac{\text{C t}}{0.3133 \text{ L}} \ldots\ldots\ldots\ldots (2)$$

which means that the density (lines per square inch) in any path which does not include a magnetic mineral or metal is equal to the ampere-turns per inch length of the path, divided by 0.3133.

Conversely, the number of ampere-turns required to produce a certain magnetic density in a space not occupied by magnetic minerals may be ascertained by means of the formula

$$0.3133 \text{ B L} = \text{C t} \ldots\ldots\ldots\ldots (3)$$

or stated as a rule, the ampere-turns are equal to 0.3133 times the density, multiplied by the length of the path in inches.

Letters on Practical Subjects

A Single-Track Block-Signal System.

To the Editor, American Electrician;

Sir:—The accompanying diagram shows the connections of one complete block of a railway block-signal system devised by the writer. The system consists of two switches, *A* and *B*; two lamp wires, *C* and *D*; two ground wires, *E* and *E*; and a feeder wire, *F*. The switches, *A* and *B*, are represented as plain insulated bars pivoted in the center and carrying contact strips at each end. There are two red lamps and two white lamps at each signal box, the red lamps at one box being connected in series with the white lamps at the next box by one of the wires, *C* and *D*. The switches must, of course, be kept closed in one or the other extreme position. The operation for a single-track road is as follows: A conductor entering a block, say, from the left of the diagram, and finding the switch *A* in the position shown, will find the white lamps burning, the circuit being complete from the feeder wire, *F*, through the lower right-hand switch contacts, the two white lamps, the lamp wire, *D*, the two red lamps at the other signal box, and the switch contacts, to the rail. This will indicate that a car already in the block is going in the same direction as the car just entering it. Should a car approach the block from the other direction, the conductor of that car will find the red lamps at *B* burning, indicating that a car approaching him from the opposite direction has entered the block, and he will accordingly keep on the siding. After the car going from *A* to *B* has passed, the waiting car proceeds into the block (the direction of travel of this car being from right to left on the diagram), after the conductor has closed the switch *B* to the position shown by dotted lines. This lights the white lamps at the signal box, *B*, and the red lamps at the signal box, *A*, preventing the next car traveling from left to right from passing the signal box *A* until the car which has the right of way has reached it. In such a case, of course, the signal boxes would be located at sidings.

The system was more particularly designed for a length of single track which was in common use by several different railways, in which case only two signal boxes were required; one at each end of the stretch of single track. The system has the advantage of indicating to conductors at both ends of the block section the direction in which the car having the right of way is going; the red lamps indicating that a car in the block section is approaching the observer, and the white lamps giving, of course, the opposite indication.

P. E. Moock.

Canton, Ohio.

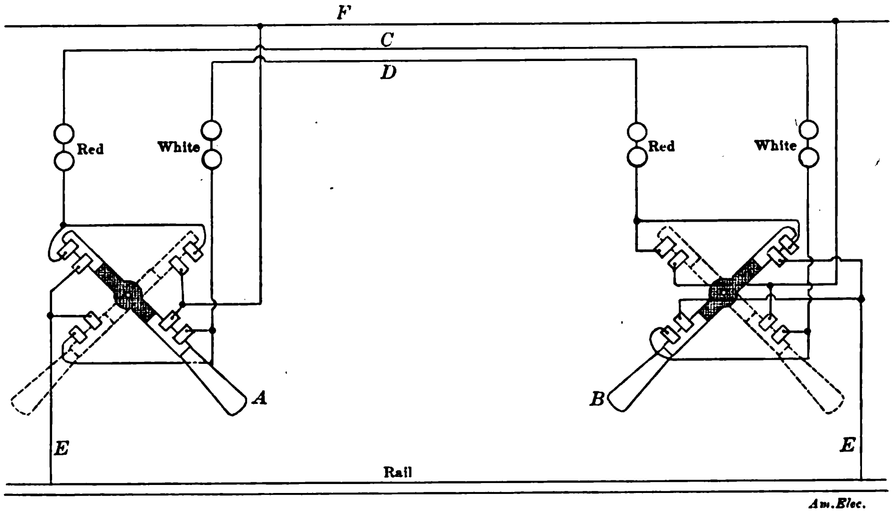


FIG. 1.—SINGLE-TRACK RAILWAY BLOCK-SIGNAL SYSTEM.

An Odd Mishap.

To the Editor, American Electrician;

Sir:—I was called recently to trace out a peculiar trouble in an isolated plant. The dynamo was a 150-light 110-volt bipolar Jenney machine and was carrying about 100 lamps. The engineer accidentally closed the switch on the board which connected the dynamo circuit with the city mains supplying 104-volt alternating current, with the result that the fuse on the dynamo terminal board instantly blew. After discovering the mistake, the engineer opened the alternating-current switch, shut down the dynamo, and replaced the fuse. After starting up the dynamo and raising the voltage to a point that seemed to be about right, an inspection of the voltmeter showed that the instrument would not register. An examination disclosed the fact that the resistance coils in the rear of the voltmeter case had been burnt out. When new coils were obtained and connected up and the meter put back in circuit as it had been originally connected, the needle was deflected away from the scale, showing that the polarity of the dynamo had been reversed. I should like for some of your readers to suggest an explanation of the reversal, and also the burning out of the meter resistance coils when none of the lamps in the circuit was injured.

O. C. Thompson.
New Albany, Ind.

Working a Signaling System Under Difficulties.

To the Editor, American Electrician;

Sir:—The enclosed diagram shows the arrangement of a signaling system that the writer rigged up to meet an emergency and which has worked satisfactorily ever since it was put in. The problem consisted of establishing a signaling system between a power-house and a dredge, the location of which was, of course, constantly shifted. The distance from the power-house to the dredge varied between 2000 and 4000 ft. The dredge motors are supplied through service wires from the pole line on shore to cable reels on the dredge, the shore end of the service wires being shifted along from pole to pole as the dredge moves along in the water.

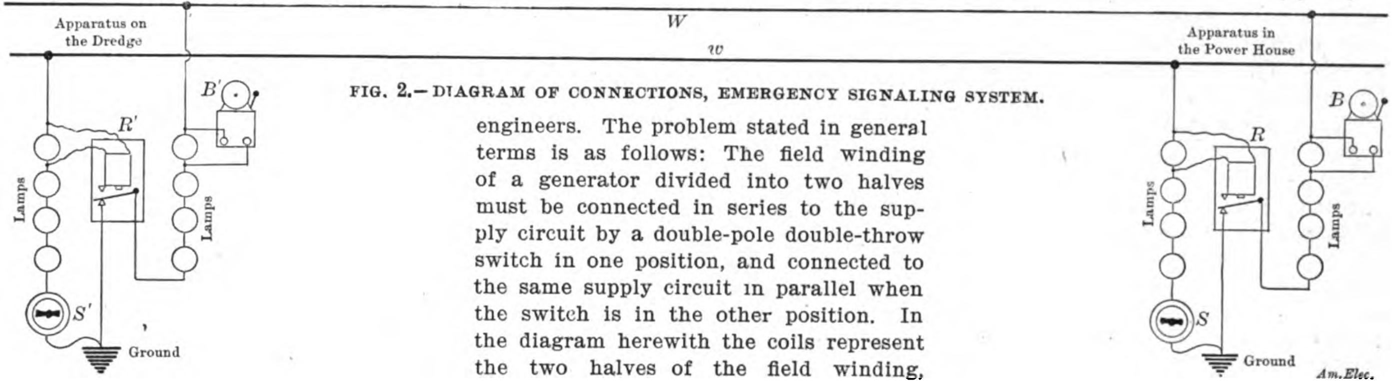


FIG. 2.—DIAGRAM OF CONNECTIONS, EMERGENCY SIGNALING SYSTEM.

Referring to the sketch, *R* is a relay, the armature of which, when unattached, closes a local circuit from ground through four incandescent lamps to one of the service wires, *W*. The signal bell is connected in shunt to one of these lamps. The relay magnet is connected in shunt to one of a group of four lamps connected in a branch from the other service wire, *w*, to the ground; in this branch is a snap switch, *S*. The arrangement on the dredge is exactly the same as that at the station. It is evident that upon closing the switch, *S*, the service wire, *w*, will be grounded through the left-hand group of lamps at the power house, and as the service wire, *W*, is grounded through the right-hand group of lamps at the dredge, the bell, *B'*, will ring. The magnet of the home relay, *R*, will also be energized, attracting its armature and cutting out the home bell, *B*, and its group of lamps. Upon opening the switch *S*, the home relay will drop its armature, so that signals can be received from the dredge in the same manner as just described.

The object in using a double group of lamps at each end is to prevent burn-outs in case of an accidental solid ground on one of the service wires. For example, a group of four lamps could be used in series with each switch, and a single lamp in shunt with the bell could be connected between the service wire, *W*, and the ground at each end, but with such an arrangement, if the service wire, *w*, should become solidly grounded, the lamp and bell of course would be burned out.

Bannack, Mont. E. R. Avery.

Field Connection Problem.

To the Editor, American Electrician;

Sir:—Some time since the writer was confronted by a problem in field winding connections which, although not particularly difficult, was a little illusive at first, and may be of some interest to younger engineers. The problem stated in general terms is as follows: The field winding of a generator divided into two halves must be connected in series to the supply circuit by a double-pole double-throw switch in one position, and connected to the same supply circuit in parallel when the switch is in the other position. In the diagram herewith the coils represent the two halves of the field winding, the circles at the right of the diagram represent the terminals of the supply circuit, and the double-throw switch is represented by six contact jaws.

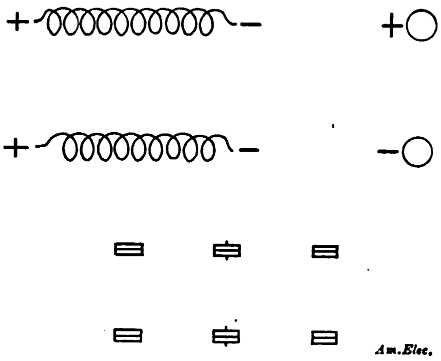


FIG. 3.—CONNECTION PROBLEM.

F. P. Woodbury.
Niagara Falls, N. Y.

Alternating-Current Conduit Wiring.

To the Editor, American Electrician;

Sir:—A firm of contractors in an Illinois town, one of whom had money and the other claimed to have experience, undertook a job of interior wiring recently, with the result that the experienced partner now has what money he could collect before he left town and the other member of the firm is busy obtaining experience, and incidentally spending more money overhauling the work his partner did not have knowledge enough to satisfactorily install. The wiring job was a rather simple one, consisting of feeders and mains for 18 constant-potential alternating-current arc lamps. The length of the feeder was over 100 ft., and the wires were installed each in a separate iron pipe conduit. The results of this misdirected effort to do a good job from the underwriters' standpoint can easily be imagined by those familiar with alternating-current phenomena, but as the contractors and some others interested in the installation were not familiar with this class of work they were considerably startled by what happened. The iron pipe enclosing each wire got very hot and the drop of voltage from the source of supply to the lamps was about 70 volts, although the wire itself was cold. For the benefit of any wireman who is not familiar with the peculiarities of alternating currents, it may be as well to explain that the heating of the pipe was due, not to any leak or short-circuit, as a good many supposed in the foregoing case, but to the rapid magnetization and demagnetization of the iron pipe by the alternating current in the wire. The wall of each pipe formed a closed magnetic circuit about the wire within it, exactly like the iron core of a shell-type transformer does about the coils which it encloses. The reversals of magnetism in the wall of the iron pipe caused a loss by hysteresis which was very much greater relatively than the core loss in the transformer, because the pipe was unannealed, and, of course, not laminated. The excessive drop in voltage was due to the self-induction of the wire caused by the presence of the iron wall around each wire, the effect being the same as though a coil of wire with an iron core having a closed magnetic circuit had been inserted in the line. The only remedy for the two evils is, of course, to put both wires in a single pipe, so that each neutralizes the magnetic effect of the other one, or else to use a conduit of some other material.

Chicago, Ill. C. R. James.

A Problem in Lamp Control.

To the Editor, American Electrician;

Sir:—The accompanying diagram represents five outlets for incandescent lamps, five switches, each one controlling the outlet immediately above it, a tablet board from which the system is supplied, and an emergency switch, the function of which is to connect all of the lamps to the supply circuit in an emergency, regardless of whether they were previously

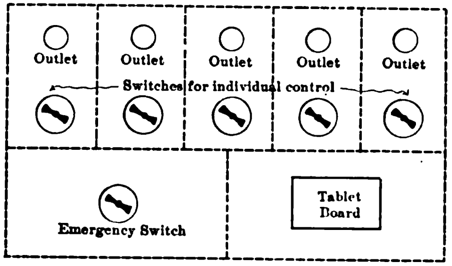


FIG. 4.—PROBLEM IN LAMP CONTROL.

lighted or turned off by their individual switches. It may probably be of some interest to readers of the American Electrician to work out the wiring connections necessary to obtain these results. It should be remembered in considering this problem that the ordinary double station control, whereby lamps may be turned on and off from either station, is not contemplated. In the present case the emergency switch must connect all of the outlets with the live circuit, regardless of the positions of the individual switches, the latter merely serving to turn the lights on and off when the emergency switch is in the off position. The switches to be used must be of standard form, such as can be bought in open market, and there are only two conductors running from each of the outlets.

I have installed a system of this kind in a residence recently, and it has proven of great convenience. The object of the system is to provide a means for illuminating the entire house or any predetermined section of it in case of emergency, such as fire, sudden illness, burglary, etc.

St. Louis, Mo. Chas. J. Sutter.

[Solutions of this problem intended for publication must be received not later than December 15.—Editor.]

Electrical Catechism

655. Are any cells suitable for both intermittent and continuous work?

A storage cell is suitable for both kinds of work, provided not too long a period of idleness is imposed upon it, in which case the cell gets out of order and loses its charge. There are a few primary cells that are well adapted for continuous work, and will also stand idle without any deleterious action. One of the best known of these is the Edison-Lalande cell.

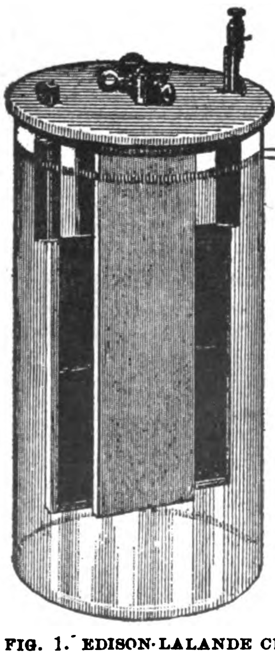


FIG. 1. EDISON-LALANDE CELL.

656. Explain the action of the Edison-Lalande cell.

In this cell the positive electrode is composed of one or more plates of zinc, and the negative electrode consists of a slab of copper oxide held in a frame of copper. The electrolyte is a strong solution of caustic soda ($NaOH$) or caustic potash (KOH). When the cell is working the zinc dissolves, forming sodium (or potassium) zincate (Na_2ZnO_2), displacing hydrogen, which moves with the current to the negative plate, where it unites with the copper oxide, forming water and metallic copper. The solution is always covered with a layer of heavy paraffine oil, both to prevent evaporation and also to prevent the carbonic acid gas of the air from acting on the solution. When the oil is not used the life of the cell is reduced to about one-third. The Edison-Lalande cell gives about 0.7 volt. The Gordon cell is similar to the Edison-Lalande, except that the zinc is made into a cylinder surrounding the inactive element, which consists of a perforated tin cylinder filled with copper oxide.

657. What governs the amount of current delivered by a battery of one or more cells?

The current from a battery, like that from any other source, is governed by Ohm's law. The current (measured in amperes) equals the e.m.f. (measured in volts) divided by the total resistance of the circuit (measured in ohms). This resistance includes the resistance in the external circuit, and also the internal resistance of the cells. If the resistance of the external circuit is high, as is the case with telegraph lines, the internal resistance of the cells is but a small part of the whole, and the cells are connected in series to give a high e.m.f. If the external circuit is of low resistance, the resistance of a single cell may be high as compared with that of the external circuit. The internal resistance of a cell is less as the electrodes are larger and closer together. By connecting together similar electrodes of several cells, they all act as one large cell having much less resistance than any one, the combined resistance of several cells of similar size and construction being equal to that of one divided by the number of cells connected in multiple. Thus, if the resistance of one cell is 1 ohm, the resistance of five cells coupled in multiple is one-fifth of an ohm. Cases often arise where it is best to make a combination of series and parallel, connecting the cells in several sets having an equal number of cells in series and then connecting these sets in multiple. The greatest output is obtained when the resistance of the cells equals that of the line, but this is not the most economical arrangement, since half of the energy is then lost in the cells. For the highest economy, the internal resistance of the cells should be as low as practicable in comparison with the resistance of the external circuit.

658. What is a storage battery?

A storage battery is one which, when exhausted, can be recharged by sending current through it from another source. The basis of each electrode is a "grid" or plate of solid pure lead, with sometimes the addition of a little antimony to make it harder. This plate is cast, rolled or cut into a shape that gives a large amount of surface, a common method being to make a series of parallel grooves. The grooves are then filled with active material, either by the mechanical application of lead oxide or by the action of acids which attack the surface of the metal until the interstices are filled with a spongy mass of lead oxide. After being thoroughly washed to remove the oxidizing solution, the plates are set up in a dilute solution of sulphuric acid (H_2SO_4), often known as "oil of vitriol;" the alternate plates are connected and current is sent through from one set of plates to the other; current is then cut off and the plates are connected through a resistance so as to deliver current and become discharged; current is then sent through them again for a longer time and they are again discharged. After this operation has been repeated several times, the plates are formed and are ready for use. Small cells are sent out from the factory ready for filling with acid and for charging. For larger cells, such as used in central stations, the plates are shipped separate and are set up and connected where the battery is to be used. In a battery for central station use, all of the positive plates of one cell are "burned" or fused to a lead connecting strip, to which also are fused all of the negative plates of the next cell; in this way all of the cells are rigidly connected into one series. In smaller batteries it is common to have the corresponding plates of each cell fused to a common terminal strip, and the different cells are coupled by means of lead-covered bolts, or in some cases, by rubber covered flexible copper cables bolted to the lead terminals.

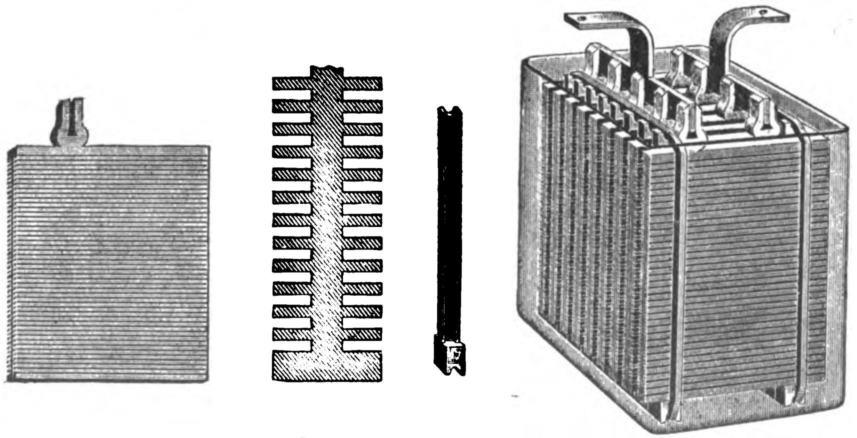


FIG. 2.—MODERN STORAGE BATTERY.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

Why is it desirable to put parallel wires carrying alternating currents as close together as possible? W. J. C.

In order to reduce the self-induction of the line as far as possible.

Please recommend a book on elementary principles from which I can learn the relation between amperes, volts, kilowatts, and other units. A. K.

Study the Lessons department, beginning with the September number.

Can the current from the secondary of an induction coil be transformed into direct current of high potential? W. L.

Not commercially; the current can be changed into pulsating direct current by means of a chemical rectifier, but this is not a very practical process.

How can I change a 100-volt Thomson recording wattmeter to work on a 50-volt circuit? L. C. R.

It is extremely inadvisable for you to attempt to make any change in such a delicate instrument. You can use the wattmeter with reasonably accurate results on a 50-volt circuit just as it is by dividing its constant by 2.

Can an ordinary series open arc lamp be converted to an enclosed arc lamp by merely adding an inside globe? G. J.

No; the regulating mechanism will have to be adjusted for a longer arc, so that the difference of potential across the carbons will be about 70 volts. If the existing mechanism cannot be so adjusted, then new magnets will have to be wound which will do this.

Can a four-pole dynamo or motor with a lap armature winding be operated with two brushes? (2). Can the lap-wound armature of a four-pole machine be changed to a two-path winding? The present coils have 16 turns each. A. F.

Yes; by cross-connecting the commutator, so that each of the brushes will be in connection with the segment diametrically opposite the one on which it rests. (2). Yes; use the same wire, two strands in parallel, and twice the present number of coils minus 1, putting four turns in each coil instead of 16.

Two alternators belted and speeded alike when thrown in parallel, refuse to divide the load properly. The larger machine drives the smaller one as a motor. Can this be remedied? J. M. G.

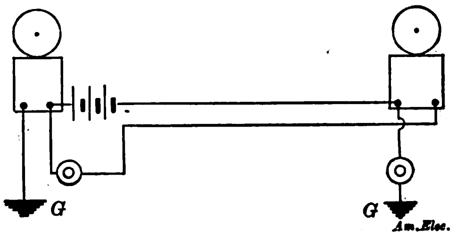
A positive answer cannot be given without complete knowledge of the machines and their behavior. On general principles it may be stated that the trouble may be eliminated by adjusting the governor of the engine driving the smaller alternator so as to increase its speed, making a series of very slight adjustments until the small machine takes its share of the load.

Under what conditions will an alternating-current wattmeter run backward? (2). Will a power factor of less than 50 per cent affect the direction of rotation? H. E.

Such a wattmeter will not run backwards unless the series coils are connected up backwards in the circuit or unless the power is reversed through the instrument. For example, if two alternators are working in parallel, with wattmeters connected in the individual leads between the machines and the bus-bars, and one of the alternators motorizes the other one, then the wattmeter in the leads of the motorized alternator will run backwards. (2). The power factor has no influence upon the direction of rotation.

Can a return-call bell system be operated with a single set of batteries? If so, what are the connections? J. J. D.

Such a system can be operated by the use of two line wires and a ground return, as indicated in the accompanying diagram. A return-call system can also be operated with varying degrees of satisfaction by connecting a resistance coil in the line at each end and arranging the push button to short-circuit this resistance coil and the home bell when it is pressed; the latter arrangement is rarely satisfactory, however.



Can more than two 110-volt direct-current arc lamps be controlled by one switch and protected by one fuse block? (2). Can a customer be supplied with three-wire service individually from 220-volt two-wire street mains? W. F.

A single fuse block is not allowed to protect a circuit carrying more than 660 watts, but there is no limit to the amount of load that can be broken by a single switch, except of course the carrying capacity of the switch. (2). Three-wire service can be supplied from two-wire mains by installing either a small storage battery or a motor-balancer on the premises. A simpler method of supplying service would be to use 110-volt lamps connected two in series across the 220-volt circuit.

How can I operate a 45-volt open arc lamp on a 110-volt circuit? (2). I have a dynamo using carbon brushes which make a great deal of noise; could this be remedied by substituting metal brushes? F. H. W.

Put a dead resistance of iron wire in series with the lamp, making the resistance about 7 ohms. (2). Either your brushes fit too loosely in the holders or the quality of carbon is too hard. If the brushes are very loose, put liners of thin sheet copper in the holders until the chattering stops, being careful not to jam the brushes. If this does not remedy the trouble try softer brushes, such as graphite. It would not be safe to substitute metal brushes, as the machine is designed for carbon brushes and sparking would probably result.

A water dimmer made of a glass tube, ¼-in. bore and several inches long, filled with water, and containing an electrode fixed at one end, and a movable electrode inserted in the other, will not serve its purpose in series with six 110-volt lamps in parallel. I get no light until the movable electrode is brought into contact with the fixed electrode at the bottom of the tube; what is the trouble? C. T. P.

The cross-sectional area of the path through the water is too small, making the resistance too high, even with the electrodes very close together, to pass sufficient current to light the lamps. Try a glass tube 2 ins. in diameter and add a little salt to the water. Make your electrodes in the form of a round disc very little smaller than the bore of the glass tube. An Argand lamp chimney will serve admirably for the retaining tube.

How are the outside feeders of a three-wire system calculated? (2). What is the proper ratio between the size of the neutral wire and the size of the outer wires? C. S. E.

The outer wires are calculated exactly as though the system were a two-wire system of the voltage used between the outer wires. Thus, if the voltage from the neutral to each outer wire is 115 volts, the total voltage will be 230, and the outer wires should be figured just as the wires of a 230-volt two-wire circuit would be figured. (2). There is no fixed ratio between the neutral and the outer wires. For ordinary purposes it is sufficient to give the neutral wire one-half the cross-section of one of the outer wires. In large office buildings equipped with isolated plants the plan is sometimes adopted of operating the plant on the two-wire system from the local generator and turning it into a three-wire system in cases of emergency when supplied from the city circuit. In such a case the neutral wire must have twice the cross-section of one of the outside wires.

What is the easiest way to extract roots other than square and cube roots? (2). What is the difference between the root of a number and the power of a number? G. T.

Find the logarithm of the number from a table of logarithms, and divide it by the index of the root to be extracted; the result will be the logarithm of the desired root, which can be found by using the table of logarithms backward; that is, by finding that number the logarithm of which is the result of the division performed. (2). The root of a number is the value which, multiplied by itself the number of times indicated by the index, will produce the number of which it is the root. For example, the cube root of 8 is written $\sqrt[3]{8}$, the index being 3. The cube root of 8 is 2, and multiplying 2 by itself three times produces 8. The power of a number is the value which is obtained by multiplying the number by itself as many times as there are units in the exponent. For example, 8^3 means the third power of 8, and its actual value is obtained by multiplying 8 by itself three times, the exponent being 3; the numerical result is 512, and this, therefore, is the third power, or cube of 8.

DIRECT-CURRENT MOTORS IN BROOKLYN NAVY YARD SHOPS.

The tools in the carpenter shops at the Brooklyn Navy Yard have recently been changed over from steam to electric drive, and the results are reported as being eminently satisfactory. The machinery in the carpenter shops comprises three band saws, each requiring 15 horse-power; one circular saw, requiring 15 horse-power; one log shifter, requiring 25 horse-power; three surface planers, requiring 15, 20 and 25 horse-power, respectively; one four-side planer, taking 50 horse-power; one large circular saw, requiring 100 horse-power, and several smaller machines requiring from 2 to 5 horse-power each. The motors which have been installed are Thresher machines, and the method of application in most cases consists of coupling an individual motor to the tool, as indicated in Fig. 1, which shows one of the planers driven by a 20-h.p. motor, and Fig. 2, showing one of the band saws direct driven by a 15-h.p. motor. Most of the motors are of the completely enclosed type illustrated in Figs. 1 and 2, and the enclosure is literal, the doors over the commutator and other parts of the motor being rubber-gasketed and held in place by screw pressure. The joints are sufficiently tight to allow the motor to be immersed in water without injury if the bearings were provided with suitable stuffing boxes.

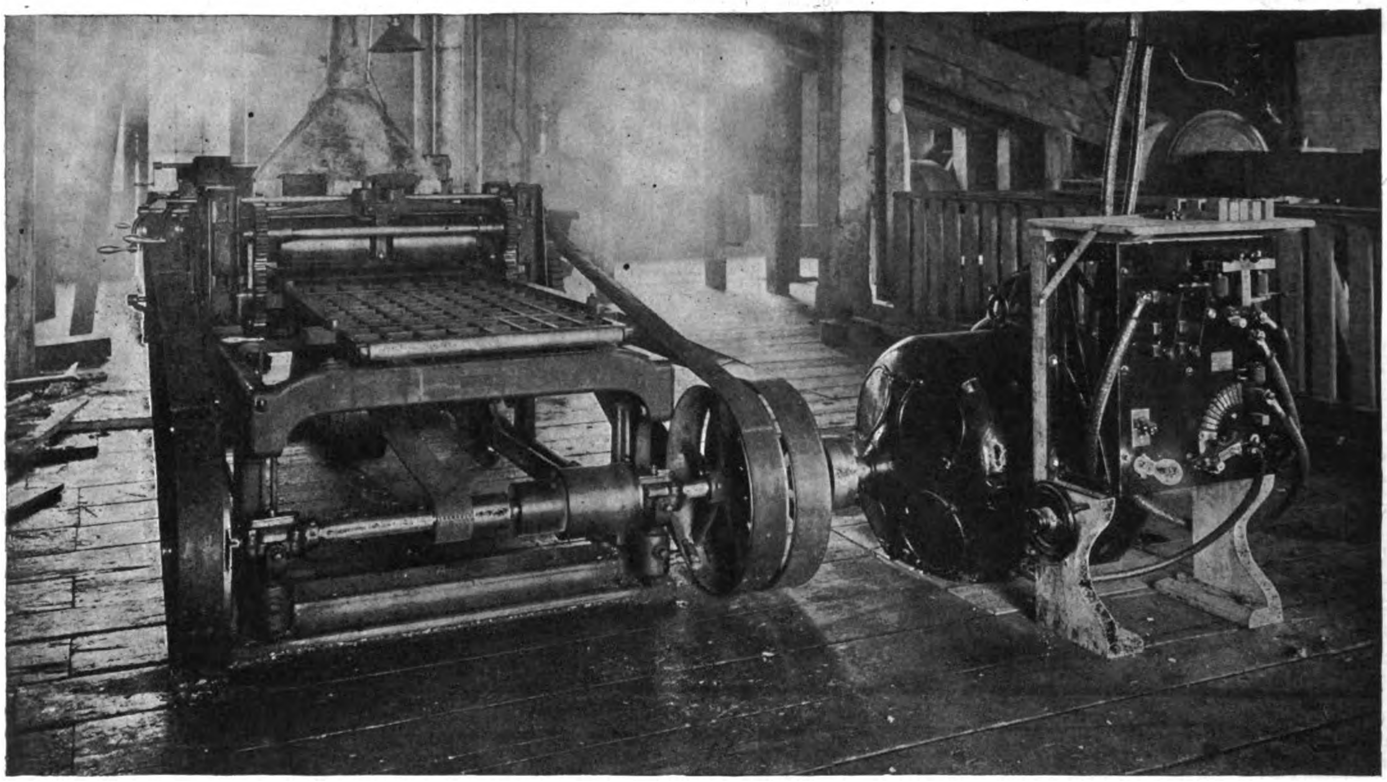


FIG. 1.—MOTOR-DRIVEN PLANER IN BROOKLYN NAVY YARD CARPENTER SHOP.

The accompanying tables give test data for several of the representative motors of the installation, Table I giving the manufacturer's specifications, Table II giving data taken from tests up to full load, and Table III giving the results of overload tests. It will be observed that in every case the efficiency actually developed by the motors is higher than the rated efficiency, in some cases the improvement being remarkable. The 5-h.p. motor, for example, is rated at 86 per cent full load, but actually developed 89 per cent efficiency, and the 15-h.p. motor, rated at 86 per cent, developed the surprising figure of 92 per cent at full load. One of the most remarkable results shown by the test figures is the small rise of temperature from no load to full load, the greatest rise in field temperature (by the resistance method) being 47 degrees. For a complefely enclosed machine this is unusually low, and indicates a highly conservative rating on the part of the manufacturer.

TABLE I.—SPECIFICATIONS.

		Efficiency.						Brushes		Armature.			Commutator.		
H.P.	r.p.m.	½	¾	Full.	Type.	Poles.	Br'hs.	Brushes per h'l'r.	Brush dimen.	Diam.	Slots.	Gap.	Diam.	Lgth.	Segments.
5	1100	80	84	86	Encl	4	2	1	1 x 2	9	51	¼	6	2½	51
10	450	80	83	85	Encl	4	2	2	¾ x 2	14	51	¼	12	6	51
15	400	81	84	86	Encl	4	2	2	2 x 1	16	51	¼	12	6	51
20	800	83	85	87	Encl	4	4	3	3 x 1½	16½	140	¼	10	6	140
25	800	82	86	88	Encl	4	4	3	½ x 2½	16	120	¼	10	6¾	120
100	600	86	90	92	Open	6	6	4	2½ x 1½ 2¼ x 1½	23	134	¼	20	10	154

TABLE II.—LOAD TESTS.

Voltage, 110; Run, 8 hours.

	R.P.M.							Resistance				Temp. rise, by resistance.		Efficiencies.			
				Full load.				Cold.		Hot.							
H.P.	¼	½	¾	Hot.	C'ld.	Ave. r.p.m.	Am.	Arm.	F'ld.	Arm.	F'ld.	Ar.	F'ld.	¼ l'd.	½ l'd.	¾ l'd.	Full l'd.
5	915	...	...	960	915	915	38	.0673	137.5	.0754	157.1	28	33	..	..	..	89
10	452	452	450	453	440	450	74	.0369	70.9	.....	81.4	..	35.3	69	83.6	88.5	88.5
15	...	395	...	408	397	390	112	.021	42.8	.0259	51.2	21.8	47	74	86.8	89.5	92
20	802	800	...	810	800	800	140	.0293	45.8	.....	..	..	..	..	..	88.4	91.3
25	804	802	800	800	800	800	180	.0196	41.9	.0225	45.8	36	20.6	70.6	84	91.3	92.2
100	496	...	...	512	488	500	717	.00997	21.5	.0107	24.4	27	32.2	..	..	..	92.4

One of the very interesting features of the installation is a relay type of controller board, which was built by the Cutler-Hammer Manufacturing Company. This board controls two motors driving the four-sided planer; 25-h.p. motors are used, either one of which alone drives the planer on light work, both of them being, of course, thrown in for heavy work. The controller board is a duplex arrangement, one-half controlling the circuits of one motor and the other half those of the other motor, and works on the relay system. A master controller, resembling a small rheostat, closes circuits through the various solenoids which actuate the main switches. The first step of the controller gives the motors full field; the next step connects the two armatures in series through all of the external resistance coil; further steps cut out the resistance in successive sections, and this is followed by the insertion of resistance in series with the shunt field, increasing the

TABLE III.—OVERLOAD TESTS.

Run, 2 Hours.

		Resistance hot.		Temp. rise, by resistance.	
Amp.	R.P.M.	Arm.	Field.	Arm.	Field.
46	990	.077	157.1	35	33
94	453	.0441	81.4	46	35.3
106	409	.024	51.1	37	47
170	800	.0339	..	38	..
221	800	.0232	45.8	42	20.6
1055	516	.01086	..	27	..

speed of the motors. The next step connects the armatures in parallel, restores all of the resistance in series with them, and cuts out the resistance in series with the field; the successive steps repeat the operations that were performed with the armatures in series. The switches which make the change from series to parallel armature connections are mechanically connected by a rod extending across from one section to the other of the controller board, so that it is impossible for the switch which puts the motors in parallel to be closed at the same time with the one that puts the armatures in series.

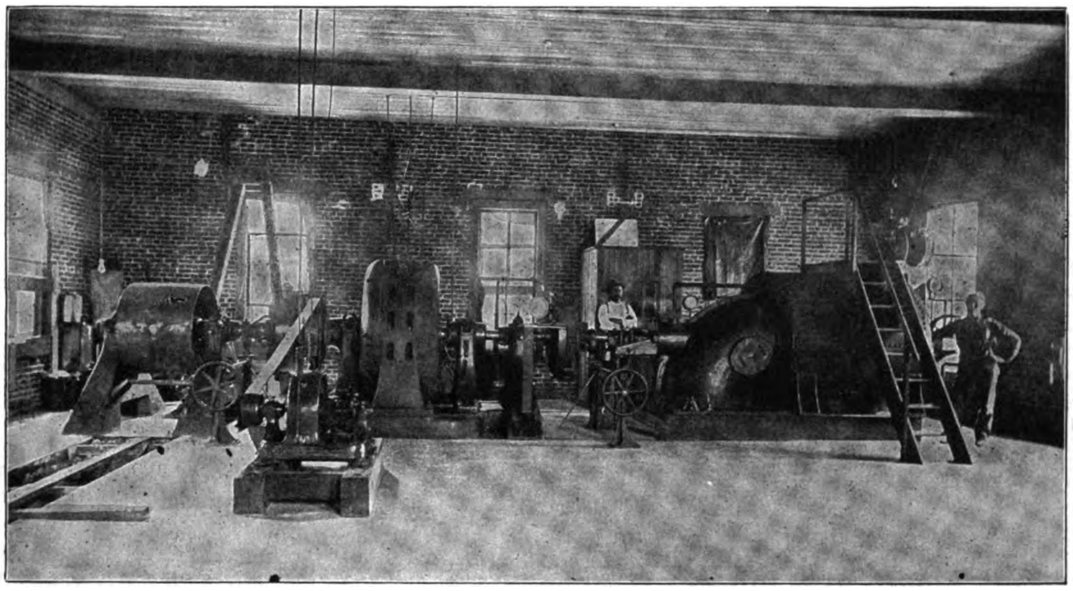


FIG. 1—POWER PLANT OF THE WALLA WALLA GAS AND ELECTRIC COMPANY.

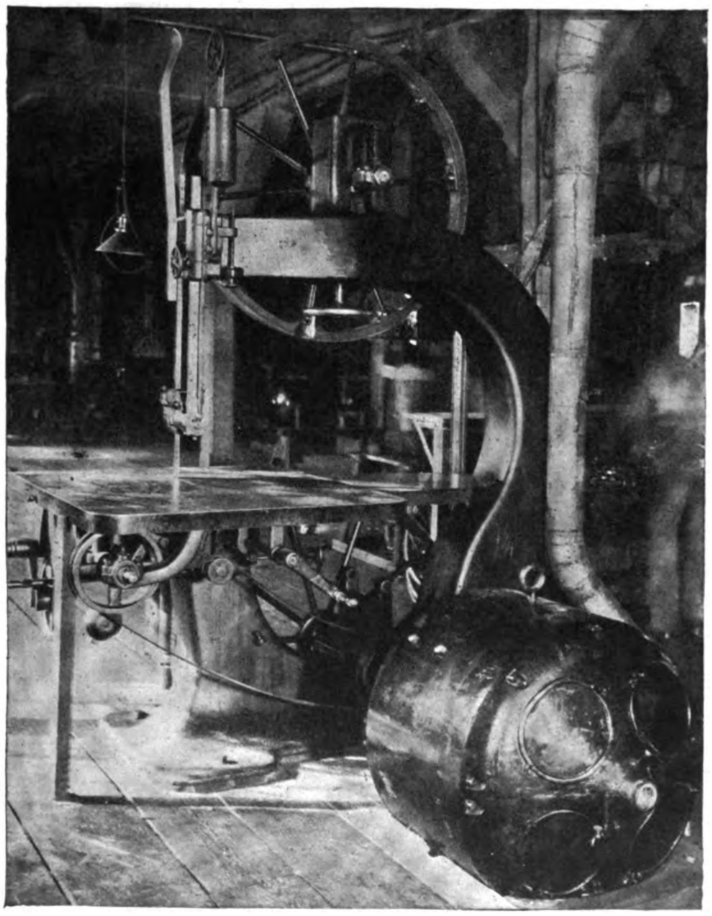


FIG. 2—MOTOR-DRIVEN BAND SAW, NAVY YARD SHOP.

This plant has displaced a 12 x 12 in. engine with its boiler and accessories, about 210 ft. of shafting, and a ¼-turn mule or idler. In addition to greatly reducing the maintenance charges and the amount of attendance necessary, the change in the plant has effected a coal economy, basing electric power on the consumption of 5 lbs. of coal per horsepower hour, of nearly 66 2-3 per cent, the exact ratio of coal consumption being 120 to 43. The reduction in attendance which has been effected is striking; formerly an engineer, a fireman, and an oiler, the aggregate wages of whom were $7.60 a day, have been displaced by the partial services of an electrical inspector who devotes only a portion of his time to examining and keeping up the motor equipment, the value of the time actually devoted to this work being estimated at $1.00 a day.

TURBINE-DRIVEN POWER PLANT.

In the spring of the present year the Walla Walla (Wash.) Gas and Electric Company completed a water power plant for the supply of electric current to Walla Walla. The plant is located on Mill Creek, and is interesting from the fact that it employs the monocyclic system and includes a rotary engine in its auxiliary equipment. The water is taken from the creek, 5600 ft. distant from the plant, where a concrete dam spans the stream, and is conveyed to the power house through a 4-ft. stave pipe built of red wood; the available head being 82 ft. 6 ins. The pipe is buried the entire distance. The monocyclic generator is driven by a 450-h.p. McCormick turbine, 27 ins. in diameter, built by the S. Morgan Smith Company, of York, Pa. The water wheel is direct connected to the generator, which is a 300-kilowatt revolving-field machine, delivering current at 6600 volts and a frequency of 60 cycles. The exciter is a 7½-kilowatt multipolar dynamo, driven from the generator shaft. A 400-h.p. rotary engine of the Thomas & Brumagin type is installed and belted to a Hill clutch pulley on the generator shaft, so that the generator can be driven by either water or steam, or both, as occasion may require. The end thrust of the wheel is taken up by lignum-vitæ steps, one set being in the wheel case and another set in the discharge pipe. The wheel is fitted with a Replogle relay governor, as shown in Fig. 1, which gives a general view of the generating equipment.

◆

A NEW SELF-STARTING SINGLE-PHASE MOTOR.

The great demand for a single-phase induction motor, which can be started from standstill without resort to mechanical means, has led to a number of attempts to produce such a machine, most of these attempts taking the form of phase-splitting devices used in conjunction with auxiliary windings on the stator of the motor. The most recent method is that embodied in the new self-starting single-phase motor of the General Electric Company, which comprises broadly the provision of a polyphase winding on the stator and the connection of one phase of the winding to the supply circuit and another phase to a small condenser. In practice a three-phase winding is used, one phase of which is shunted by the condenser. The result of this arrangement is to effect a displacement of the magnetic phases of the windings and to produce a rotating field such as that inherent in an ordinary three-phase motor. Since the output of a condenser of given size varies as the square of the voltage at its terminals, the condenser used in connection with motors wound for low voltages is not connected directly to the stator winding, but to the terminals of a small compensator which raises the e.m.f. at the condenser terminals to 500 volts. The condenser and compensator are assembled in a single casing and permanently connected to the motor, which is started exactly like a three-phase motor, by simply closing a switch in the case of a small machine, or manipulating a special starting switch which limits the initial current, in the case of larger motors.

Fig. 1, herewith, gives the power and efficiency curves taken from a ½-h.p. 125-cycle motor. It will be noted that the machine shows the remarkable power factor of unity between 80 per cent of its normal load and 10 per cent overload, and that the slip at full load is only 3 per cent, which is vastly better than a direct-current motor of the same size would be expected to do. The maximum efficiency is attained at 30 per cent overload, the full-load efficiency being 66 per cent, while the maximum efficiency is 67½ per cent. The full-load power factor of this motor is scarcely more remarkable than the power factor at starting, which is considerably higher than the running power factor of an ordinary induction motor of this size. The excellent power factor of the machine is, of course, due to the condenser.

The ¼ and ½-h.p. motors are provided with centrifugal-clutch pulleys in order that they may be started free. The clutch consists of a split ring, the segments of which are pressed outwardly by means of centrifugal weights when the proper speed has been attained, the segments of the ring engaging the inner surface of the pulley and thus transmitting power from the motor shaft to the pulley by friction.

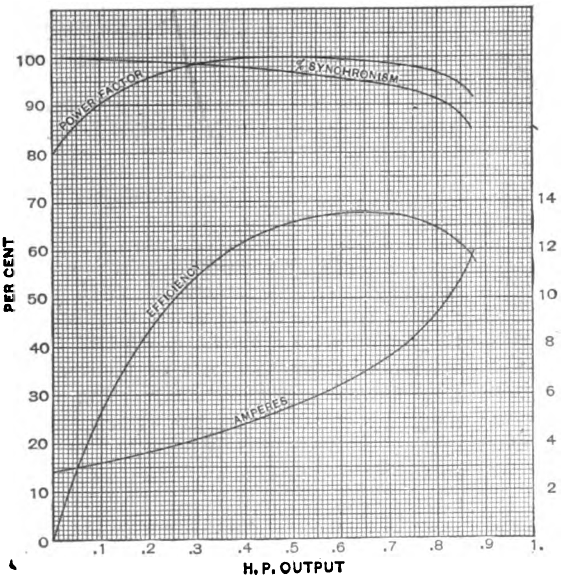


FIG. 1.--INDUCTION MOTOR CURVES.

PELTON ELECTRIC RELAY WATER WHEEL GOVERNOR.

The electric relay water wheel governor made by the Pelton Water Wheel Company of San Francisco and New York, and illustrated by Fig. 1 consists of three principal parts: a regulator, speed governor and electric relay. The regulator consists of a ratchet wheel keyed to a shaft in connection with the nozzle hoods or deflecting nozzle. This shaft is also fitted with a wheel for hand control. Two rocker arms, each carrying two pawls, rock about the ratchet wheel shaft by means of eccentric rods and eccentrics keyed to the main driving shaft. The pawls do not engage the ratchet wheel until the soft iron armatures attached to them are attracted by the electromagnets; one pair of electromagnets controlling the pawls which cause the ratchet wheel to turn in one direction, and another pair of magnets controlling the pawls which cause it to turn in the opposite direction. The brake against the ratchet wheel is set just tight enough to hold the wheel in the position in which it is placed by the action of the pawls.

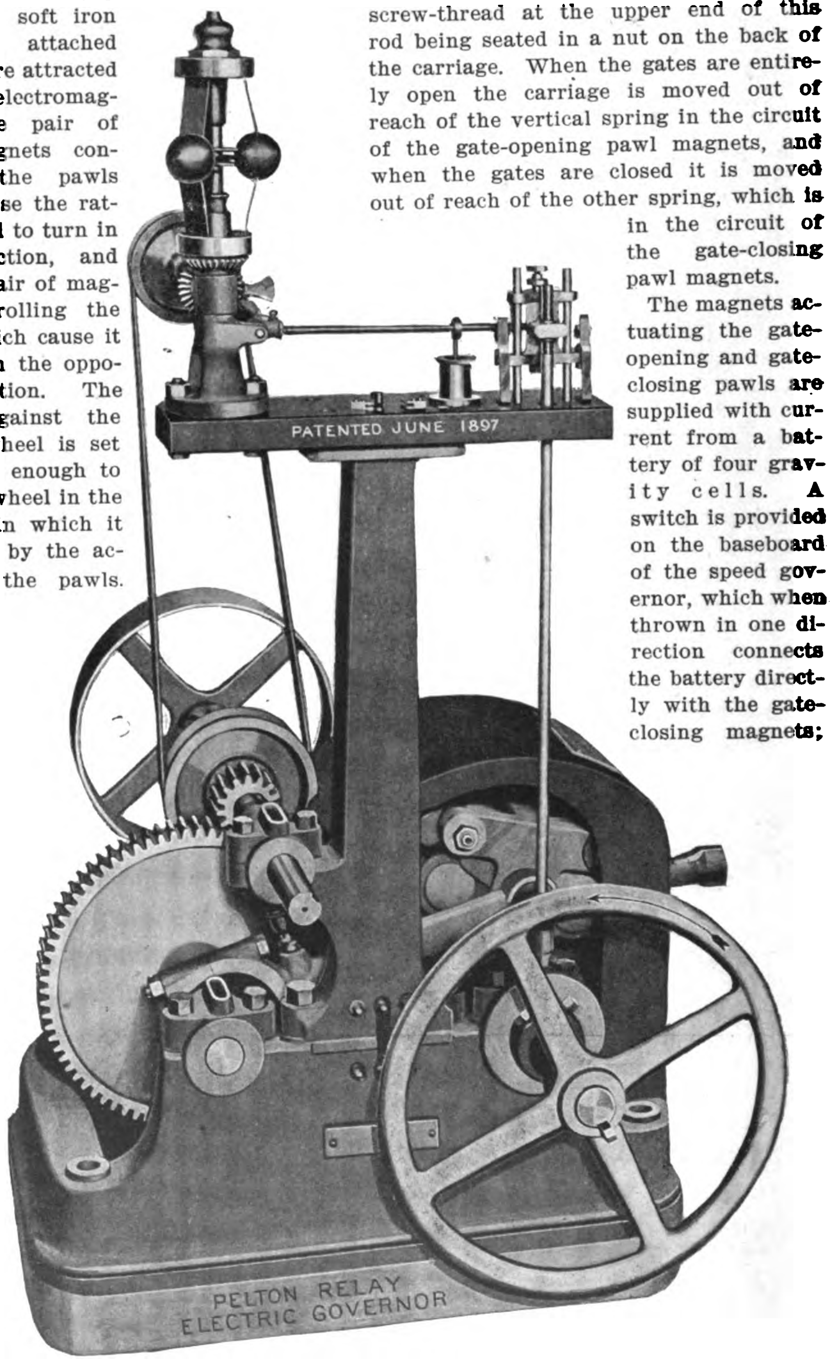


FIG. 1.—PELTON ELECTRIC RELAY GOVERNOR.

The speed governor is an ordinary flyball affair of the Pickering type, and is arranged so that the balls vary the position of the horizontal arm extending outward from the base of the governor. This arm carries at its free end a platinum contact which changes of speed cause to oscillate between two platinum-pointed screws mounted on a little carriage, which is adapted to slide up and down on two posts. The governor arm, when in contact with one of the screws, closes the circuit through the electromagnets which set the gate-closing pawls, and when it is in contact with the other screw the other set of pawls is thrown into action. The motion of the governor arm is steadied by a small dash-pot. The circuits from the two contact screws on the relay carriage pass to the two sets of pawl magnets through two vertical springs at each side of the carriage. The carriage is moved by the rotation of the vertical rod extending upward from the gate gear, a screw-thread at the upper end of this rod being seated in a nut on the back of the carriage. When the gates are entirely open the carriage is moved out of reach of the vertical spring in the circuit of the gate-opening pawl magnets, and when the gates are closed it is moved out of reach of the other spring, which is in the circuit of the gate-closing pawl magnets.

The magnets actuating the gate-opening and gate-closing pawls are supplied with current from a battery of four gravity cells. A switch is provided on the baseboard of the speed governor, which when thrown in one direction connects the battery directly with the gate-closing magnets; when thrown in the opposite direction it connects the battery to the governor contacts for regular operation. In starting up, this switch is put in the middle position, and the turbine is brought up to speed by means of the hand-wheel.

New Apparatus and Appliances

A NEW FUSELESS ROSETTE.

The widespread adoption of multiple feeders and central distributing panels has led to an extensive use of fuseless rosettes, the policy being to centralize safety devices as much as possible. To meet the growing demand for this class of ceiling rosette the New England Electric Manufacturing Company, of Boston, Mass., has designed the form illustrated by Fig. 1. The chief feature of this rosette is that the lamp cord is threaded outward through two small holes after being carried once through the center hole, and is then carried back again through the center hole to the terminal clips. This obviates the necessity for tying a knot in the cord in order to avoid putting the weight of the lamp on the ends of the cord under the binding screws.

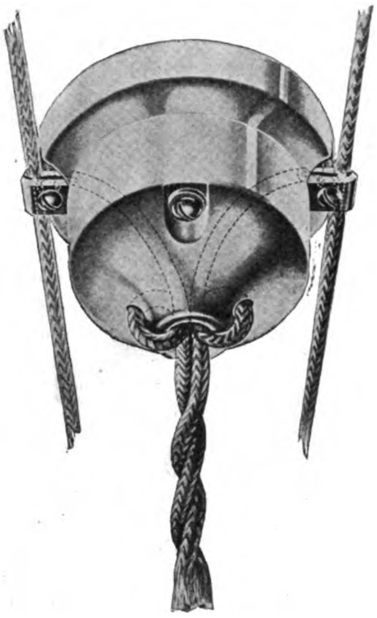


FIG. 1.—FUSELESS ROSETTE.

PARABOLIC ADJUSTABLE REFLECTOR.

The accompanying engraving illustrates a very convenient form of reflector designed for use on lamps disposed horizontally, and made by the Faries Manufacturing Company, Decatur, Ill. The reflector itself is parabolic in shape, and, as the illustration shows, it almost completely encloses the bulb of the lamp. The holder is ingeniously simple, consisting merely of spring fingers which clamp the end of the lamp socket and which are bent near the tips so as to conform to the surface of the bead around the mouth of the socket. The fingers clamp the end of the socket with sufficient firmness to hold the reflector steadily at any angle to which it may be turned. The reflector is made of either aluminum or steel, as may be preferred, and in two sizes, the smaller size for use with standard 16-c.p. and 24-c.p. lamps, and the larger size for 32-c.p. and larger lamps.

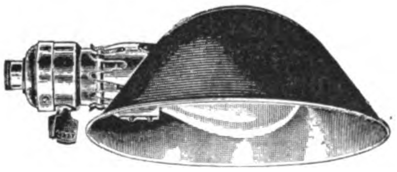


FIG. 2.—ADJUSTABLE REFLECTOR.

RELIANCE DYNAMOS AND MOTORS.

Fig. 3, herewith, shows one of a new line of dynamos and motors brought out by the Reliance Electric Company, of Milwaukee, Wis. The frame is made in one circular piece of cast steel, shaped to form feet and provided with a drop forged eye-bolt for convenience in handling. All of the type "M" machines, of which Fig. 3 is one, have four cast steel pole-pieces with shoes cast integral with the same. The machines are provided with cast iron bases, to which the steel frames are bolted in a manner admitting of easy adjustment to govern the tension on the belt. The heads or caps are reversible and made of select gray iron casting, fitted to the frame with a perfectly tight machine joint, and bolted to the frame. The bearings are gun metal and have generous dimensions, with large oil pockets and ring oilers. The armature core shown by Fig. 4 consists of double annealed steel discs coated with insulating material and assembled under pressure upon a cast-iron spider. The discs are separated at intervals with a plate forming a series of ducts, through which a constant current of air is forced when the armature is in motion. The armature coils are all form wound, and each is insulated with reliable material and subjected to a "break-down" test of 2000 volts, alternating current. After the coils have been assembled on the armature discs they are again tested before being connected to the commutator. The field coils are also form-wound and are slipped over the magnet cores before the latter are bolted to the frame, the pole-pieces holding them in place. The brush holders are mounted on a ring, which is fitted to a circular recess in the face of the end cap, and adjustment is effected by means of the handle shown in Fig. 3.

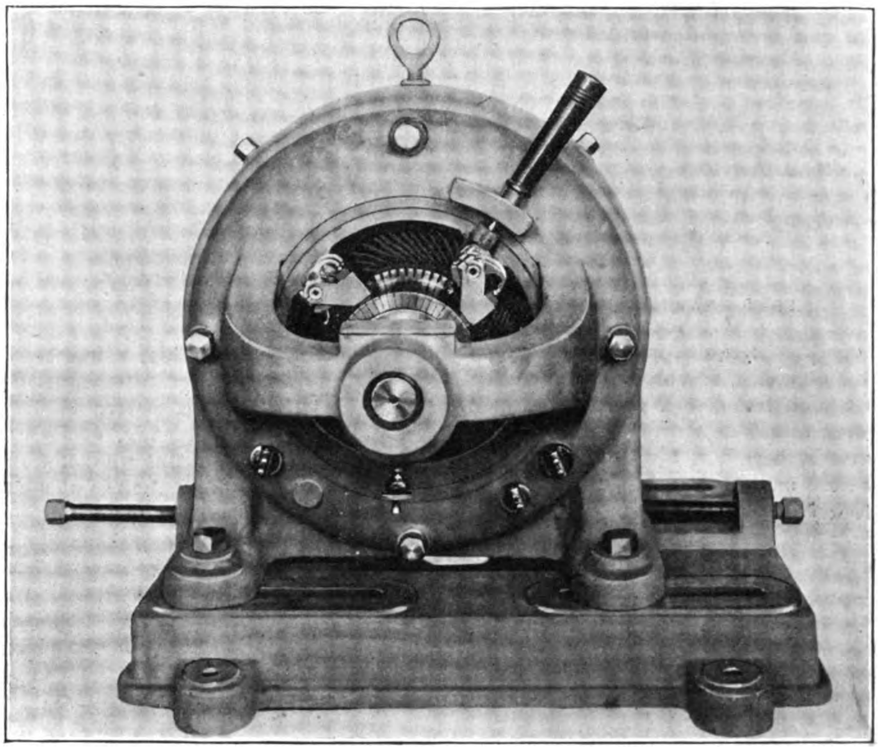


FIG. 3.—TYPE "M" RELIANCE DYNAMO OR MOTOR.

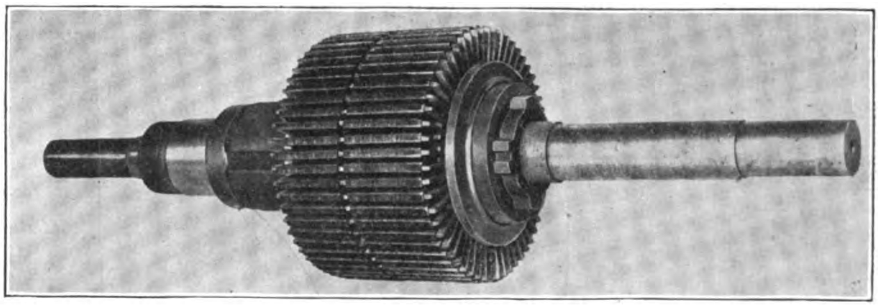


FIG. 4.—ARMATURE CORE AND SHAFT, RELIANCE DYNAMO.

FLASHERS FOR ILLUMINATED SIGNS.

Fig. 5 shows a new flasher made by the Reynolds Electric Company, of Chicago, for electrically illuminated signs. The flasher consists of a number of cam-wheels mounted on a common axle, which is driven by an electric motor, and a corresponding number of switches. The axle revolves at the rate of 2½ r.p.m., and each cam operates a quick-break knife-blade switch for making and breaking the circuit through one lamp or a group of lamps, according to the design of the sign. Special care is bestowed upon the construction of the switches, as the manufacturer has found from experience that even so simple a thing as a knife-blade switch is very likely to get out of order under continuous service of this kind; the trouble being not with the arc made the moment the circuit is broken, but with poor contact at the time the circuit is closed, and poor contact in the pivot of the blade of the switch. The former trouble is due to a lack of flexibility in the switch jaws and is overcome in the Reynolds flasher by mounting each jaw on two phosphor-bronze springs. Poor contact in the pivot of the blade is obviated by providing a large rubbing contact at the pivot and carefully fitting the surfaces.

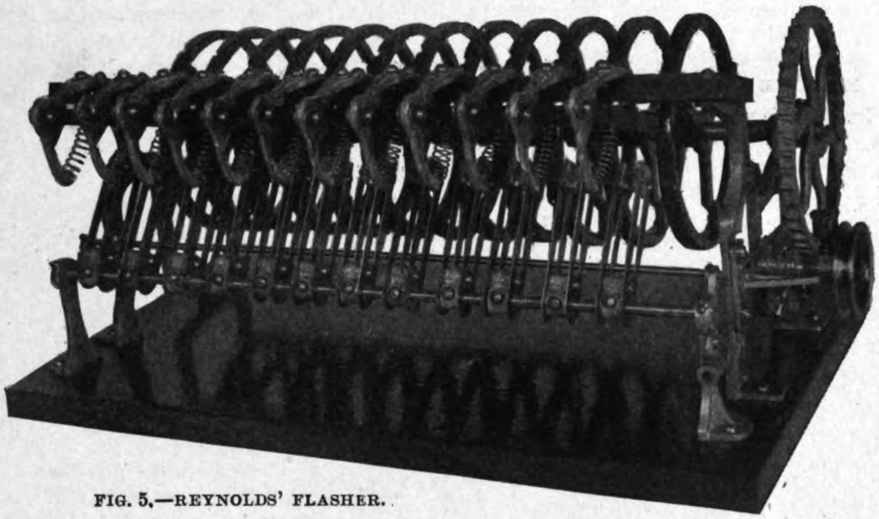


FIG. 5.—REYNOLDS' FLASHER.

NEW ATTACHMENT FOR FEED-WATER HEATERS.

Usually when installing a feed-water heater so that it may be cut out for cleaning purposes or inspection, a number of straight-way valves and fittings are required. To simplify this matter the Hoppes Manufacturing Company, of Springfield, Ohio, has brought out what it terms an "induction chamber"; the use of which necessitates no other fittings, valves or pipes than the main upright exhaust. Fig. 6 shows very clearly the construction of this attachment, which is bolted to the back end of the heater. The exhaust passes upward through the chamber, and as much of the steam as is required to heat the water flows into the heater through a large downwardly curved pipe, the end of which is in line with the flow of steam through the chamber. A small pipe leads from near the bottom of the chamber to a point slightly above the center of the chamber, and serves to carry off from the steam space the air and other non-condensable gases, so that the steam may freely enter the heater. The heating of this pipe by the exhaust inside the chamber, and the current of steam passing its upper end, are said to cause the circulation which carries the gases into the upper chamber, from which they pass out with the exhaust steam. In order that the heater may be cleaned while the plant is in operation, valves are provided for both inlet and outlet connections to the heater. This attachment is said to also act as an oil separator, troughs being partly filled with water, as shown in the illustration, and working on the principle of the company's oil eliminator.

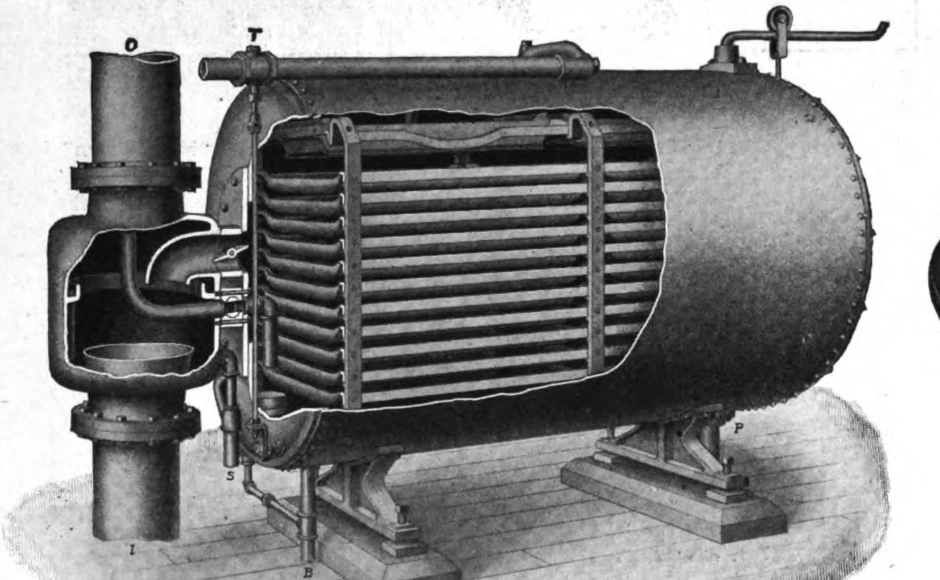


FIG. 6.—INDUCTION CHAMBER ATTACHED TO FEED-WATER HEATER.

WATER-TIGHT FLOOR OUTLET BOX.

Floor outlet boxes have always been one of the weakest points of a wiring installation, being exposed to water and dirt when floors are scrubbed and swept, and from the nature of their location subjected to hard usage. The G. I. floor outlet box, made by the General Incandescent Arc Light Company of New York, parts of which are illustrated herewith, is said to be designed to successfully meet these conditions. Fig. 8 shows the box with the nozzle removed and the flush plug in place in the center of the cover, and Fig. 7 shows a double brass outlet nozzle, the holes of which are bushed with hard rubber having rounded edges and

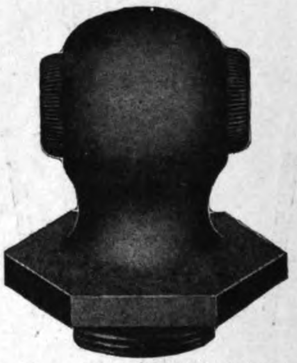


FIG. 7.—DOUBLE OUTLET NOZZLE.

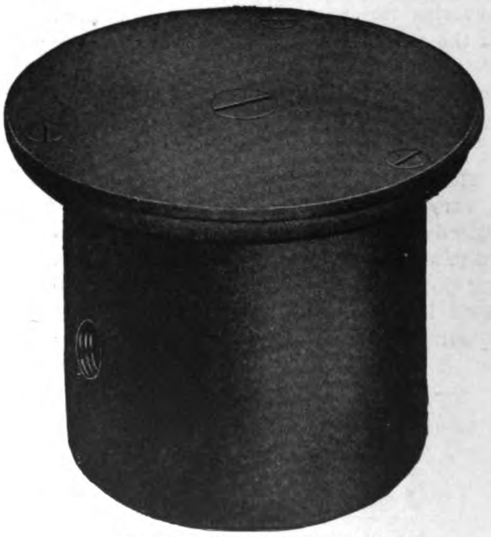


FIG. 8.—FLOOR OUTLET BOX.

screwed into the nozzle. The box is made of heavy cast-iron, with a floor plate of brass or iron 3-16 in. thick. It is provided with gaskets at the joints and leaded where screw-thread connections are made, in order to make it thoroughly dust and water proof. The flexible cord leads out from the side of the outlet nozzle, where it cannot be stepped on, or the insulation crushed against corners of outlets. When not in use a flat brass plug can be screwed into the floor plate, making the whole surface flush with the floor. Porcelain enamel lining is applied to the inside of the boxes if desired.

NEW ECK MOTOR.

The Eck Dynamo & Motor Works, of Belleville, N. J., have just designed and brought out a new type of motor, shown by Fig. 9, which embodies a number of features of interest. The field consists of a circular yoke of such section as to secure good efficiency without being unduly heavy, and the magnet cores are of round wrought iron, set deeply in the magnet frame to insure large contact surface. The pole-shoes are shaped so as to produce a uniformly-distributed field in the air-gap, and sparkless operation is said to be obtained under all changes of load without shifting the brushes. The armature core is of the slotted type, with form-wound coils. The winding is first baked to remove moisture, then dipped in insulating varnish and again baked. The brush-holder, shown by Fig. 10, has a concave surface, *b*, fitting the convex end, *a*, of the brush, which is given sufficient play to adjust itself to the curve of the commutator surface, but the center of the circle of which the curve, *a*, is an arc is so near the commutator that the brush cannot turn out of position. A flat tempered steel spring, *f*, presses the brush-holder against the brush, the tension being adjusted by a screw, *e*. Two or more copper strips, *d*, running along the under side of the steel spring, carry the current. The semi-enclosed and enclosed types of motors are provided with patented swivel shields, which expose the interior of the machines to view and permit easy access to the brushes by simply turning the shield a quarter of a turn. The machines are provided with a combination sliding base and oil pan, in order to collect any oil which might otherwise drip upon the floor.

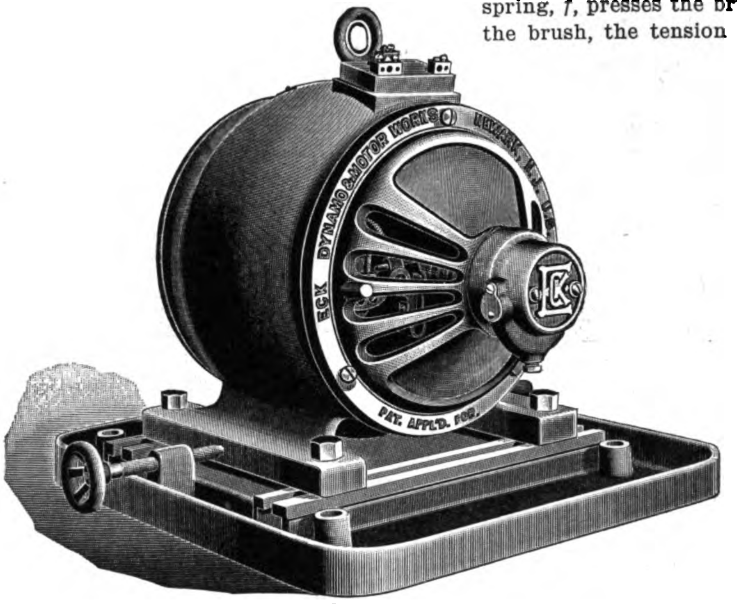


FIG. 9.—ECK MOTOR.

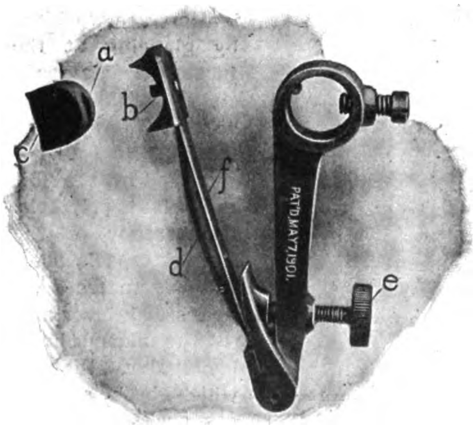


FIG. 10.—ECK BRUSH HOLDER.

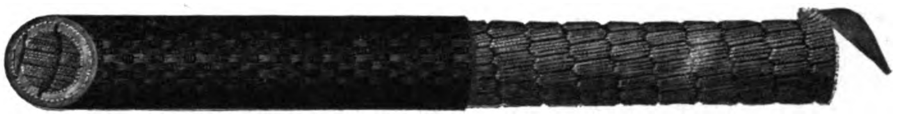


FIG. 11.—FLEXIBLE CONDUIT.

A NEW FLEXIBLE CONDUIT.

The Osburn Flexible Conduit Company, of New York and Hoboken, N. J., has put on the market a new variety of flexible conduit known as "Flexduct" and illustrated by Figs. 11 and 12. Its basic material is woven fiber and the general construction may be inferred from the illustrations, which show the outer covering, the inner tube, and a section of the tube split open to exhibit the interior. The tube is closely woven; the strands of the warp passing over and under the spiral alternately, and the weaving being longitudinal, a smooth and unresisting surface is presented on the inside. The warp forms the inner lining, which is parallel to the tube. It is evident therefore that the spiral cannot be unwound and that the interior cannot be ripped out, the whole constituting practically one member. Outside of this flexible fibrous tube is woven a cotton covering which is saturated with an insulating compound. The fibrous interior of the tube is also filled with a special compound of high insulating quality, thus insuring a high insulation resistance between the wire contained in the conduit and any external object. The manufacturer claims that mere adhesiveness in construction is not depended on, but the interweaving makes the conduit mechanically strong, prevents its drying out and renders it always supple and yet tough.

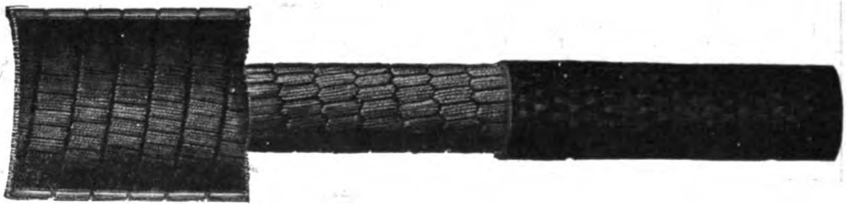


FIG. 12.—FLEXIBLE CONDUIT.

"L-H" ENCLOSED ARC LAMPS.

Figs. 13 and 14 show the "L-H" enclosed-arc lamp made by the Anderson Tool Company, of Anderson, Ind., for constant-potential, direct-current circuits. The frame is made of bicycle tubing substantially put together, and has few parts. The cover is made in one piece and can be readily lowered by removing two small thumb screws; while the shade is fitted to a spun ring and is supported by a chain as shown when lowered for trimming. Sliding contacts are avoided; a flexible cable directly connects the sole-

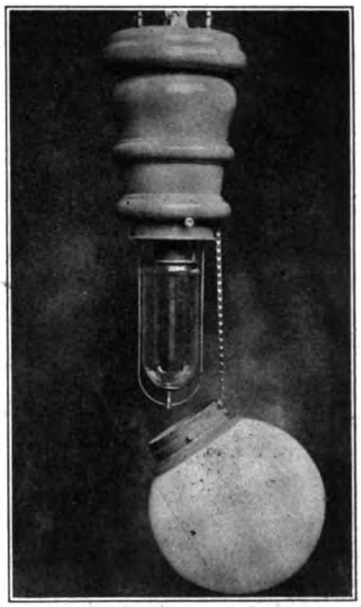


FIG. 13.—L-H. ENCLOSED ARC LAMP.

noid with the end of the carbon, thus insuring a direct and positive connection. A pair of solenoids wound on brass spools with soft iron ends is provided, and, should occasion require, these may be easily removed. The clutch used is a modification of the well-known Brush clutch, made of two pieces of cold rolled steel punched into suitable shape. The dash pot consists of an outer brass shell fitted with two steel ball valves and a fiber graphite plunger. These plungers are said to be free from expansion and are self-lubricating. By the use of valves in the dash pot, it is claimed, the arc forms when the lamp "picks up," avoiding the flicker so often seen in arc lamps. The resistance used is hard spring wire wound into a small spiral coil and fastened to porcelain insulators in the top of the lamp. The covers are of spun and polished aluminum; but oxidized copper, scoured or polished brass covers may be had if preferred. The inner globe is ventilated slightly, and a carbon life of from 150 to 175 hours is claimed.

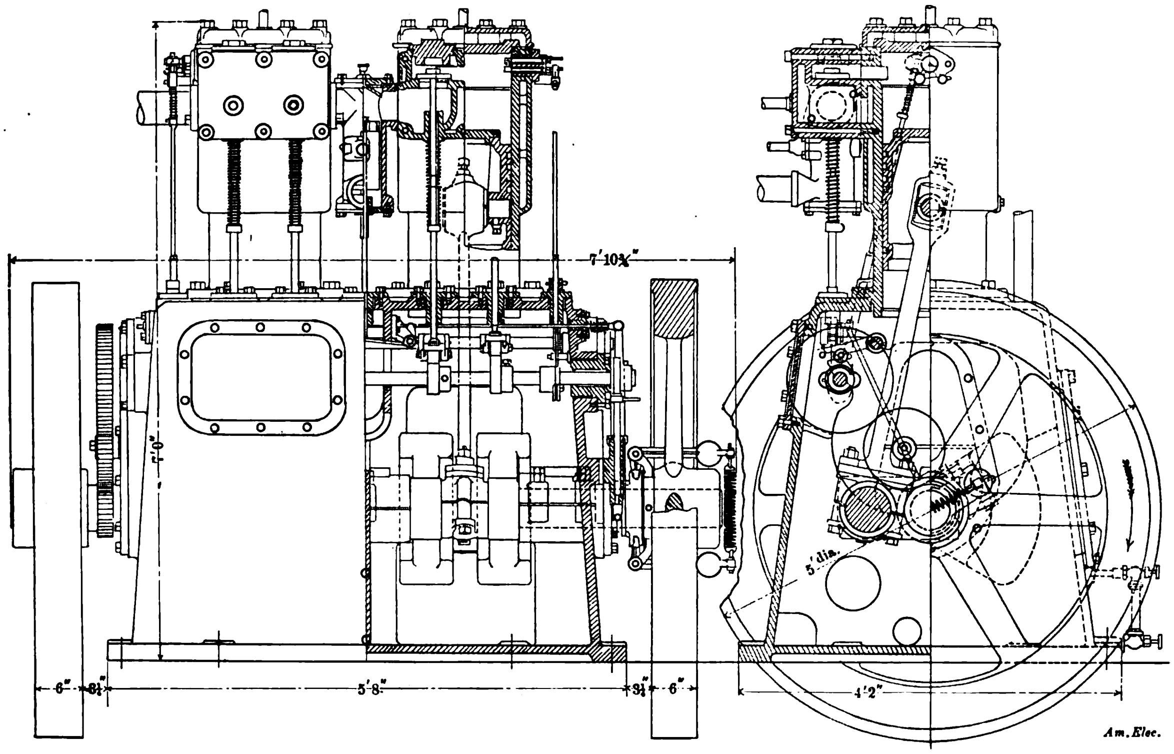


FIG. 15.—SECTIONAL VIEW OF MAYWOOD GAS ENGINE.

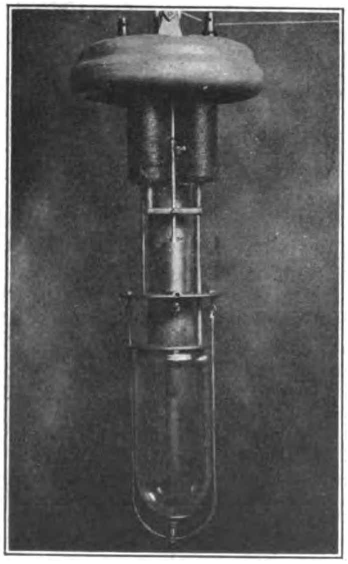


FIG. 14.—L-H. ENCLOSED ARC LAMP.

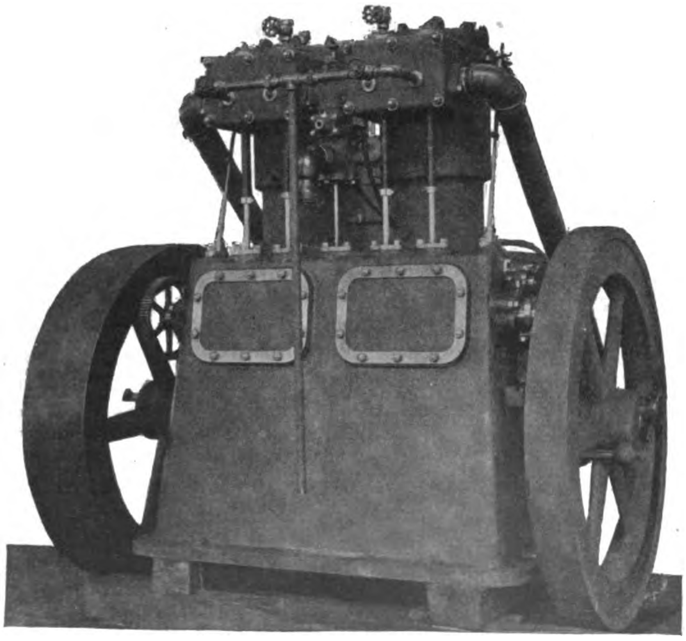


FIG. 16.—MAYWOOD GAS ENGINE.

MAYWOOD GAS AND GASOLINE ENGINE.

The Maywood Foundry and Machine Company, of Maywood, Ill., is building the type of gas engine shown by Figs. 15 and 16, with a view to meeting the demand for an engine of this class to drive electric generators running under rapidly-varying loads. The Maywood engine is of the vertical multiple cylinder type, with the crank shaft, cam shaft, rocker shaft, connecting rods and all main bearings and working parts enclosed in an oil-tight base running in an oil bath which furnishes lubrication to all parts, including cylinders and pistons. Being enclosed, these parts are free from dust and dirt. The cams, cam and rocker shafts, igniter cams and rods are all accessible by removing the two front doors on the engine. The two rear doors give access to the main bearings and connecting rods. The main crank bearings are babbitted; the crank and wrist-pin bearings are of phosphor bronze. The heads of the piston are removable, so that the wrist-pin bearings may be adjusted without removing the piston. The cylinders are very heavy, with ample water jackets. The valve chests are bolted to the front of the cylinders and are so constructed that when the valve seats are worn they can be bored out and bushed. The valves are of the direct acting poppet type. The igniters have platinum-iridium points, are easily removable, and are operated by hardened steel cams on the cam shaft.

The current for the spark coil is supplied by an Edison-Lalande battery or may be taken directly from the dynamo. The manufacturer prefers to connect the supply circuit up with a double-throw switch, by means of which current from the battery may be used in starting and current from the dynamo when the engine is running. This not only saves the battery, but also furnishes a ready means for ascertaining whether or not the igniters are working, by glancing at the incandescent lamps in circuit with the igniters. The speed of the engine is not governed on the "hit and miss" principle. A governor of the fly-ball type is used, and actuates by means of a lever and rod the mixing chamber valve, through which both air and gas are admitted in a proper explosive mixture.

The proportion of gas or gasoline to air is regulated by a valve on the outside of the mixing valve and may be instantly changed and set so as to give anywhere from one part of gas to eight of air, to one of gas to twenty of air, as the quality of the gas being used may require. A dial, over which a pointer attached to the lever operating the gas valve moves, indicates the exact proportion. Another feature in the governing of the engine is the ability to regulate the speed while running. This is done by turning a little thumb screw on the governor rod, which increases or decreases the tension on the governor spring, and causes the governor to open a greater or less distance as desired. By this means, it is said, the speed may be varied as much as 50 r.p.m. without affecting the steadiness of the power. The engine is built for either gas or gasoline and is furnished with separate gas and gasoline inlets, so that a change can be instantly made from one to the other while the engine is running; it being only necessary to open one valve and close another.

A RISING ESTABLISHMENT.

An excellent example of the results obtainable by means of business sagacity and indomitable energy is afforded by the Robbins & Myers Company, Springfield, Ohio. The company had its inception in the firm of Robbins & Myers, who started in a small way twenty-three years ago in the gray iron foundry business, and when the company took up the manufacture of electric fans these were built on the third floor of the foundry machine shop, this story having a floor area of only 3400 sq. ft. This was in the year 1896, and in 1897 the company added to its well-known line of standard ceiling, desk, and bracket fans a line of small dynamos and motors ranging from ¼ to 10 kilowatts and from 1/16 to 12½ horse-power. The business soon assumed such proportions that it was found imperative to enlarge the establishment.

A three-story brick building, containing 31,000 sq. ft. of floor space, was accordingly erected in 1900, and equipped with the most modern available tools and machinery for these lines of small apparatus. The first floor of the present factory building comprises the general machine shop, tool room, engine room, plating room, and offices; the second floor is devoted to assembling fans and motors, and on the third floor the packing department and a storage room for finished stock are located. The original gray iron foundry business has grown to a daily output of 35 tons, and the foundry has been enlarged to a floor space of 37,000 sq. ft., in which 130 molders are employed. In addition to the new factory building, the fourth story of the foundry machine shop is now entirely devoted to repair work and setting up machines. The entire plant covers three acres of ground.

The company not only enjoys a flourishing business throughout the United States, Canada, and Mexico, but is exporting to Europe large numbers of electric fans and a considerable quantity of dynamos and motors. In fact, the foreign demand for the factory's products has increased so rapidly that it became necessary to send a representative abroad to close contracts for the coming season. Mr. James A. Myers, the president of the company, has accordingly gone to Europe for the purpose of looking after the company's export business there.

NEW BOOKS.

Electric Gas Lighting. By H. S. Norrie. New York: Spon & Chamberlain. Cloth; 101 + 8 pages, 4½ x 6¼ ins.; 57 illustrations. Price, 50 cents.

This might fairly be called a companion to Mr. Norrie's "Induction Coils," although it is not quite so complete as that book. It contains descriptions of the principal forms of electrically-lighted burner and diagrams of connections for the various systems. There are also some useful suggestions concerning the installation of wires, selection of batteries and spark coils, etc.

Dynamo and Motor Testing. (Second Edition.) By E. C. Parham and John C. Shedd. New York: Electrical World and Engineer. Cloth; 627 + xii pages, 6 × 8 ins.; 211 illustrations; 8 tables. Price, $2.50.

This edition contains considerably more matter than the first edition, and most of the typographical errors that appeared in the latter have been corrected. The additions to the book comprise two chapters (XV and XVI) on street railway car equipment and tests of such equipment, which add greatly to the value of the work.

Outlines of Electrochemistry. By Prof. H. C. Jones. New York: The Electrical Review Publishing Company. Cloth; 106 + vi pages, 6½ x 9½ ins.; 13 illustrations. Price, $1.50.

The contents of this book are practically a reprint of a series of articles which appeared in "The Electrical Review." It opens with a chapter on osmotic pressure, and treats successively electrolytic dissociation, theories of electrolysis, conductivity of solutions and the e.m.f. of elements. The book is not for beginners, although parts of it are written in an elementary strain; it is rather to be used by advanced students as an adjunct to an ordinary text-book on chemistry.

Electrical Engineers' Pocket-Book. By Horatio A. Foster. New York: D. Van Nostrand Company. Flexible leather; 987 + vii pages, 4 x 7 ins.; illustrated. Price, $5.00.

This is an excellent compilation of electrical engineering data, being intended to serve about the same purpose in the electrical field that Kent's pocket-book does in mechanical engineering. The book is incomplete and contains many typographical errors, of course; the preparation of a first edition of any book having the attempted scope of this one without an error or omission would be a miracle. The present production will be found of immense convenience by engineers, station superintendents and others who have to deal with electrical problems and apparatus.

OBITUARY.

JAMES W. GODFREY, general sales manager of the India Rubber & Gutta Percha Insulating Company, died November 9 from injuries received in an accident on the day of his death. Mr. Godfrey was driving on St. Nicholas Avenue with a friend in a light runabout, and on meeting a heavy truck in a poorly-lighted part of the street he turned aside and his vehicle struck a mound of gravel and was overturned, throwing both occupants to the ground. Mr. Godfrey struck heavily on his head and received a deep wound, from which he died a few hours later in the hospital to which he was taken. Mr. Godfrey was born in New York in 1855, and after graduating from college embarked in commercial pursuits, in which he was conspicuously successful. He was connected for many years with the New York Insulated Wire Company, and severed his connection with that company to form a relation with the Habirshaw Company, which lasted until his death. He was also interested in the Dale Company, manufacturers of electric light specialties, and was a leading member of the Electrical Contractors' Association of New York. He leaves a widow and two daughters, who have the sympathy of the entire electrical fraternity.

JAMES J. MURRAY, of the well-known firm of James J. Murray & Co., Philadelphia, manufacturers of electrical glassware, died on November 10. Mr. Murray's death will not make any difference in the affairs of the company so far as its customers are concerned.

PERSONAL.

MR. GEORGE BULLOCK, president of the Bullock Electric Manufacturing Company, accompanied by Mrs. Bullock, was a visitor at the automobile show in New York last month.

MR. G. A. NISBET, formerly attached to the New York office of the Electric Appliance Company, has severed his connection with that company and joined the staff of the General Incandescent Arc Light Company, New York.

MR. HERBERT LLOYD, hitherto vice-president of the Electric Storage Battery Company, has been elected president of that company to succeed Mr. George H. Day, resigned. Mr. George D. Widener, formerly second vice-president, has been made first vice-president.

MR. NORMAN H. SCHNEIDER, now in charge of all the governmental electrical apparatus at Sandy Hook, has been appointed electrical expert at Fort Hancock. Mr. Schneider is better known to electrical students as H. S. Norrie, under which pen name the valuable little treatise on "Induction Coils" was written.

MR. W. H. CRUMB, for some time general superintendent of the Pittsburg & Allegheny Telephone Company, Pittsburg, Pa., has resigned his position with that company in order to engage in general contract work. Mr. Crumb has established headquarters at 1211 Monadnock Block, Chicago, and will make a specialty of telephone engineering.

MR. A. J. WURTS, in an interesting address on the Nernst lamp, delivered at the November meeting of the Electric Club of Cleveland, stated that the recently organized Nernst Lamp Company will make the new form of lamp in both indoor and outdoor styles, with one, two, four and six glowers per lamp. The lecture was attended by about 300 members of the Electric Club and students of the Case School of Applied Science, and Mr. Wurts was bombarded with a great many technical questions concerning the action of the Nernst lamp under various conditions.

MR. JAMES P. O'DONNELL, of Chicago, has been appointed Western representative of W. H. Anderson & Sons, manufacturers of line construction tools and appliances, with headquarters at 301 La Salle Street.

MR. GEORGE H. WALBRIDGE, of the electrical engineering firm of J. G. White & Co., has returned from a business trip to Porto Rico, where the firm recently completed an electric railway system.

MR. SAMUEL W. GLOVER, the popular president and treasurer of the Post-Glover Electric Company, Cincinnati, was married to Miss Mary Grace Herbert, of Asbury Park, N. J., on November 20. Mr. Glover's marriage was a surprise to his many friends, but this fact has not dampened the ardor of their congratulations.

MR. C. E. RICHMONDT has disposed of his interest in the Richmondt Electric Wire Conduit Company, Waukegan, Ill., and will embark in business at St. Catharines, Ontario, Canada. Mr. Richmondt expects to establish a tube works for the manufacture of interior conduit, and also contemplates the manufacture of general electric specialties.

TRADE PUBLICATIONS.

ASBESTOS FIRE-FELT COVERINGS. H. W. Johns Manufacturing Company, New York.—This is a vest-pocket pamphlet describing the various forms of asbestos fire-felt coverings that the manufacturer supplies for steam pipes, fittings, boilers, and other heated surfaces.

BLOTTER. Walker Electric Company, Philadelphia, Pa.—A magazine blotter embodying the feature of a celluloid backing on which is imprinted a picture of the switchboard for the Brandywine Railway in Pennsylvania and the business card of the Walker Company, who furnished the switchboard.

STEAM REGULATING DEVICES AND PUMPS. The Mason Regulator Company, Boston, Mass.—This is the 1901 edition of the Mason Company's pocket catalogue, the present edition containing 40 pages devoted to the well-known Mason damper regulators, reducing valves, pump regulators and steam pumps.

G. I. HIGH-TENSION OIL-BREAK SWITCHES. General Incandescent Arc Light Company, New York.—This is a bulletin forming part of catalogue No. 30, and containing illustrations and descriptions of high-tension oil-break switches, which are made in both the automatic circuit-breaker and the manually-operated forms.

LIGHT READING. New York & Ohio Company, Warren, Ohio.—This is one of Mr. Packard's latest outbursts of humorous and at the same time sensible arguments in behalf of the Packard incandescent lamp. The present publication consists of a folder containing some epigrammatic arguments, of which the following are typical: "We prove every lamp—not by a boy who looks the other way; we do it ourselves," and "It is not a remarkable achievement to make incandescent lamps, but it's lofty art to make them so they will not forget to maintain their candle-power and efficiency."

A PRETTY LIBERAL PROPOSITION. Western Electrical Supply Company, St. Louis, Mo.—A folder containing the proposition indicated by its title, the terms of which constitute a very broad guarantee for the Speer self-lubricating dynamo and motor brushes.

APPLICATIONS OF LUNDELL MOTORS. Sprague Electric Company, New York.—Bulletin No. 207, containing finely-executed half-tone engravings which show the application of the Lundell motor to a wide diversity of machinery. These motors are now used for driving all sorts of machines, from delicate dental and surgical tools up to heavy machine tools and printing presses.

ACTON VALVES. John Acton, Brooklyn, N. Y.—A catalogue of pocket size describing Acton reducing valves, pump-regulating valves, back-pressure valves, relief valves, thermostatic valves for regulating hot-water heating systems, pop safety valves, damper regulators, etc. The reducing valves are particularly simple and apparently very sensitive and reliable, judging from the construction.

RURAL TELEPHONE LINES. Kellogg Switchboard & Supply Company, Chicago.—This is Bulletin No. 6, devoted to country telephone lines, and containing complete instructions for the erection and equipment of such lines. The pamphlet is thoroughly illustrated, so that anyone who is in the least degree familiar with line construction should have no trouble in installing a telephone system for farm or similar service.

DIRECT-CURRENT MOTORS. Sterling Electric Motor Company, Dayton, Ohio.—Bulletin No. 9, describing the Sterling motor, which is built in a single size of frame to give four outputs ranging from ⅛ to ½ horse-power. The difference in output is obtained by varying the speed of the machine, and also varying the field excitation presumably, as the speed of the ½-h.p. machine is only a little more than three times the speed of the ⅛ motor

PATENT RIGHTS NOTICE. Mica Insulator Company, New York.—This company has issued a circular calling attention to the American, British and German patents covering the material known as "Micanite," which patents are owned by the company named. The notice also states that the patentees' rights have been acknowledged by most of the larger manufacturers, who have taken out licenses under them, these manufacturers including the General Electric Company, the Westinghouse Electric & Manufacturing Company, the British Westinghouse Electric & Manufacturing Company and Westinghouse Electric Company, Limited, London; the British Thomson-Houston Company, Limited, London, and the Allegemeine Elektricitäts Gesellschaft, Berlin. The Mica Insulator Company announces its intention to vigorously prosecute any infringers upon its patent rights.

GEARING. The Dayton Globe Iron Works Company, Dayton, Ohio.—This is the 1901 edition of the company's catalogue and price-list of gears. The line includes iron, spur, bevel and miter gears in all sizes and pitches, mortise bevel and spur gears with hard-wood teeth, and all-iron pinions to match these gears. The catalogued gears have planed teeth, but the company supplies cut gears of any sort when desired.

ELECTRICAL SUPPLIES. Frank H. Stewart & Co., Philadelphia.—Catalogues Nos. 7 and 8, which are excellent specimens of typographical work. Catalogue No. 7 is devoted to electric-light supplies, including the Stewart incandescent lamp, which is meeting with considerable favor, and other Stewart specialties, together with the usual line of general appliances. Catalogue No. 8 is devoted to electric bells, annunciators, burglar alarms, gas-lighting apparatus, telephone and telegraph instruments, etc.

ELECTRIC HEATING. The Simplex Electrical Company, Cambridgeport, Mass.—This is the company's seventh catalogue, in which is described a great variety of electrical heating appliances. The company's line includes every conceivable form of cooking utensil as well as auxiliary appliances, such as milk warmers, hot plate warmers, hot water urns and ship food warmers; also sad-irons, electrically-heated rolls for laundry machinery, curling-iron heaters, heating pads, glue pots, soldering irons, instrument sterilizers, radiators, foot warmers, etc.

BUSINESS NEWS.

THE D. M. STEWARD MFG. COMPANY, Chattanooga, Tenn., reports a very large demand for its lava insulators, and states that its business for the month of October was the largest in its history. The manufacturers claim for this lava insulation that its durability and insulating properties are equal to those of porcelain or mica; that it can be fused only by the intense heat of the electric arc, and that it is not soluble in any known acid. It can be turned, cut, threaded or molded accurately into any shape, it is claimed, and is therefore well adapted for the most exacting portions of delicate electrical work. The company states that within four days from the receipt of a model, drawing or blue-print, it will furnish a manufacturer with a dozen samples of its product, and within four days from the receipt of an order it can furnish 10,000 complete pieces of any kind of lava insulation.

A COMMUTATOR NECESSITY.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.
50c. per Stick. $5.00 per Dozen.

For Sale by all Supply Houses.
Upon receipt of this coupon we will send FREE, sample stick.

Name..
Address..
A. E.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO.

THE STANDARD TRACTION BRAKE COMPANY, New York City, has recently received a large order for axle and motor-driven brake equipments for the Massachusetts Construction Company, Boston, Mass.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, announces that an attachment to the Cross oil filter has been perfected that successfully prevents water from getting in oil during the process of filtering, which has hitherto given much trouble.

RELIANCE ELECTRIC COMPANY, Milwaukee, Wis., calls attention to the fact that its factory is finely equipped for the manufacture of dynamos and motors in sizes from 5 horse-power up to 250 kilowatts, and has excellent shipping facilities, so that no delay is likely in filling rush orders. The company's line includes several special machines, such as crane motors and motors adapted for driving individual machines of various classes.

I. P. FRINK, New York, reports the adoption of his window reflector by the following prominent stores: Adams Dry Goods Co., New York; Simpson, Crawford & Simpson, New York; Jos. H. Bauland Co., Brooklyn; Frederick Loeser & Co., Brooklyn; Houston & Henderson, Boston, Mass.; Lewis Dry Goods Co., Butte, Mont.; Scheutte Bros., Manitowoc, Wis.; Simon Clothing Co., Des Moines, Ia.; The Church-Dodge Co., Troy, N. Y.; L. B. Ogilvie & Co., Paducah, Ky.; Marshall & Ball, Paterson, N. J., and Browning, King & Co., Cincinnati, Ohio, and New York.

AN ATTRACTIVE HOLIDAY OFFER.—The American School of Correspondence, Boston, offers an unusual opportunity for mechanics to enroll on its student list during the present month. The school proposes to present to properly recommended students enrolling for full engineering courses during December its "Reference Library of Engineering Practice," which comprises textbooks of the electrical, stationary, locomotive, marine and mechanical engineering courses. The library consists of five quarto volumes, handsomely bound in half morocco, and containing a total of 2842 pages and 1975 illustrations.

BADT-GOLTZ ENGINEERING COMPANY, Chicago, has been dissolved, F. B. Badt having sold his interest in the business to William Goltz, who will continue the business under the style of the Goltz Engineering Company. Mr. Badt will continue in business under the name of F. B. Badt & Co., and will retain agencies for the Western Electrical Instrument Company, the Ward Leonard Electric Company, and Harold P. Brown. The Goltz Engineering Company will retain the agencies of Zimdars & Hunt, Reuterdahl Electric Company, Chas. J. Bogue, A. & W. Electric Sign Company, A. L. Ide & Sons, and the New Britain Machine Company.

THE NEW PROCESS RAWHIDE COMPANY, Syracuse, N. Y., through its English agents, Geo. Angus & Co., has recently received trial orders for "New Process" noiseless pinions from eleven of the leading electric railway companies in Great Britain. These trial orders are expected to lead to a considerable business in the near future. The company reports its trade in the general machinery line as steadily increasing, especially in the case of motor-driven machine tools where noiselessness is essential. Since the company's announcement a couple of months ago that it is in a position to furnish accurately cut metal gears, the number of orders received for work in this line has been very gratifying.

THE STILWELL-BIERCE & SMITH-VAILE COMPANY, Dayton, Ohio, reports among recent sales one to the Athens (Ga.) Electric Railway Company of two pairs of 24-in. cylinder-gate Victor horizontal turbines, to operate under a 45-ft. head; the wheels will drive electric generators.

THE ELECTRIC STORAGE BATTERY COMPANY has installed 158 batteries of Chloride accumulators in street-railway plants for the purpose of regulation, carrying the peak during heavy traffic, and for use in emergencies. These batteries, representing over 103,000 kilowatt-hours of output, cover every application of storage battery to street-railway service.

JAMES BEGGS & CO., New York, report the sale of 17 6-in. Potter mesh separators to be used in the boilers of the electric light and power plant of the Mutual Life Insurance building, New York, and that the plant of the new Stock Exchange will also be equipped with these separators. The Potter separator was described fully in the October number of this paper.

THE ELECTRIC CONTROLLER & SUPPLY COMPANY, Cleveland, Ohio, will occupy a part of the new building now being erected by the Wellman-Seaver Engineering Company as soon as it is completed, which will be about January 1. After moving into its new quarters the company will have several times its present capacity and will be able to keep up with demands for its controller for some time to come.

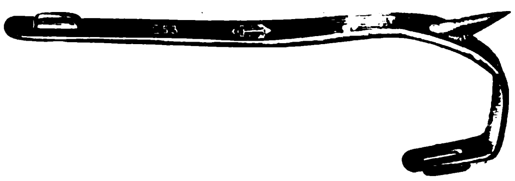
THE ELECTRIC PORCELAIN COMPANY, East Liverpool, Ohio, began on November 4 the manufacture of high-grade vitreous porcelain tubes, working at present with one kiln. The company has contracted for an additional kiln, which it is expected will be ready for use by the end of the year, at which time the manufacture of cleats, rosettes and other porcelain insulators, will be taken up. William Erlanger is president, Harry W. Peach, secretary and treasurer, and Samuel C. Dyke, superintendent of the new company.

The Telephone Service
is
The Quickest Messenger.
Rates in Manhattan from $5 A MONTH. One Year Contracts. Monthly Payments.
NEW YORK TELEPHONE CO.
y Street. 111 West 38th Street.

CREAM FLUX
An Absolutely Non-Corrosive Insulating Soldering Flux FOR ALL METALS.
So EASILY APPLIED that all CAN USE IT.
So CHEAP that all SHOULD USE IT.
So EFFICIENT that all MUST USE IT.
PUT UP IN CANS AT 15c., 25c., 45c. and 75c.
SPECIAL PRICES IN QUANTITY.
SEND FOR TRIAL BOX
Endorsed by the National Board of Fire Underwriters and all users.
We guarantee it, and if not satisfactory, money will be refunded.
FOR SALE BY ALL SUPPLY HOUSES OR
CREAM FLUX CO., SOLE MANUFACTURERS, 100 Washington St., CHICAGO

BIG STICK, 35 CENTS.
Sample Free.
SOUTHWORTH & HARE,
Indianapolis, Ind.

ERICSSON
Means best. Satisfaction guaranteed. No buzzing. Talks clear and distinct. Of neat appearance.
CATALOGUE FREE ON APPLICATION.
Ericsson Telephone Co., 296 Broadway, N. Y. City.



FOR further information about this valuable tool for Linemen see the GREEN BOOK of Hardware Specialties.
Smith & Hemenway Co.,
UTICA DROP FORGE & TOOL CO.,
296 Broadway, New York City.
Ask your Dealer for these goods.

PLATINUM
PLATINUM FOR CONTACT POINTS IN ELECTRICAL INSTRUMENTS.
PLATINUM FOR TELEPHONES. PLATINUM FOR ELECTRICAL INSTRUMENTS.
We sell PLATINUM in any quantity, either large or small. We buy PLATINUM, or anything containing PLATINUM, in any quantity.
FOR INCANDESCENT LAMPS AND EVERYTHING ELSE.
BAKER & CO.
MANUFACTURERS OF PLATINUM IN ALL SHAPES.
Newark, N. J. New York Office, 120 Liberty St.

H. KRANTZ, manufacturer of outlet boxes, has moved to 160 Seventh Street, Brooklyn, N. Y. The greatly increased manufacturing facilities which Mr. Krantz has secured in his new location will enable him to handle large orders promptly.

GEORGE WILLIAM HOFFMAN, Indianapolis, Ind., manufacturer of U. S. metal polish, polishing paste, and similar specialties, announces a steady increase in business in his line. Mr. Hoffman states that excellent reports are being received from his branch offices in New York, Chicago and San Francisco.

THE KEYSTONE LUBRICATING COMPANY, Philadelphia, recently moved into a new factory plant at Twentieth Street and Allegheny Avenue, which has been equipped throughout with the latest types of machinery for the production of Keystone grease. The company has a large demand for this grease in the United States, and it is also finding favor abroad.

MERRITT & CO., Philadelphia, manufacturers of expanded-metal lockers for car barns, factories, power stations, etc., report a brisk business in their particular line, a large number of sales having been made during the past few weeks. These lockers are finding favor with street-railway companies, and there is no reason why they should not be equally popular with electric light and power companies.

THE BULLOCK ELECTRIC MFG. COMPANY has found another extension to its plant at Norwood, Ohio, to be necessary, on account of the volume of the orders for heavy machinery that have come in during the past sixty days. Work has accordingly been commenced upon a building to be 250 ft. wide, with a main aisle 75 ft. wide, two 60-ft. side aisles, and two 27½-ft. side aisles. This building is planned to be 750 ft. long, but will not be built to the full length at the present time. The machinery will be electrically driven throughout, and there will be an electric traveling crane in each of the five aisles. The company is also installing in its power house a 1000-kw. generator direct-connected to a Lane & Bodley Corliss engine. The new foundry is being connected by side tracks to the main works, which will permit the use of a locomotive crane car for delivery of material to and from this portion of the plant.

THE REMY ELECTRIC COMPANY has been incorporated at Anderson, Ind., for the purpose of manufacturing Remy magnetos for gas-engine igniters. The company has a well-equipped factory, with a capcity of present of 15 magnetos a day.

CENTRAL ELECTRIC COMPANY, Chicago, announces that in order to meet the great demand from telephone companies for Okonite wire, a large stock of wire for this class of work will be kept on hand in addition to the usual stock of Okonite wires and cables for electric light and power lines.

WATERTOWN ENGINE COMPANY, Watertown, N. Y., has received the contract for the engines of the isolated light plant at the Hudson River State Hospital. While this order is not a particularly large one it is gratifying, because this will be the sixth installation of Watertown engines in state hospitals and similar institutions.

THE MOSSBERG & GRANVILLE MFG. COMPANY.—Several important changes have recently been made in the management of the Mossberg & Granville Mfg. Company, Providence, R. I. At the recent election the following stockholders, who have not heretofore been associated in the management, were made directors: W. W. Orr, V. I. Cumnock, E. C. Moen, A. R. Whitney, Jr., and Joseph W. Harriman, all of New York, and Elisha H. Howard, of Providence. The board of directors elected Howard C. Smith, of New York, president; Elisha H. Howard, vice-president, and E. C. Moen, secretary and treasurer. V. I. Cumnock was made chairman of the executive committee. The resignation of W. W. Gibbs, for some time past general manager, was accepted, and in his place George A. Clark, formerly of Lowell, Mass., was appointed. The business of the company at the present time is in a flourishing condition, and various new patterns of tools and machines have been added to its already very extensive catalogue.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, reports an extremely busy season, the company's factory being operated 24 hours a day at its maximum capacity. Among recent orders received are one from the Krell French Piano Company, Springfield, Ohio, for a 250-kw. generator and 57 motors, ranging from 1 to 40 horse-power; and an order from the Globe-Wernicke Company, Norwood, Ohio, for a 200-kw. direct-connected generator, five 30-h.p. motors, three 65-h.p. motors and four smaller machines, which constitutes an addition to an existing Triumph plant of two 200-kw. generators and motors, aggregating 1500 horse-power. A contract has also been secured from the Commercial Tribune Company, Cincinnati, Ohio, for one 200-kw. and one 100-kw. direct-connected generators.

THE PENNSYLVANIA ELECTRICAL & RAILWAY SUPPLY COMPANY, Pittsburg, has recently enlarged its factory, and is now in a position to handle all kinds of electrical repairs and machine work with absolute promptness. The company has special facilities for building new commutators and refilling or reassembling old ones, rewinding or making new field coils, brush-holders or any parts of electrical apparatus for any machines. The company has been appointed agent for the armature coils manufactured by the Pittsburg Armature Works, and it also handles what is claimed to be the only portable primary battery and lamp on the market that will give four candle-power for 12 hours with absolute safety and at a cost of 5 cents. The company also is agent for the Columbia Incandescent Lamp Company, and handles other high-grade electrical supplies.

APPLIED WITH A BRUSH

WARREN'S PULLEY COVER.

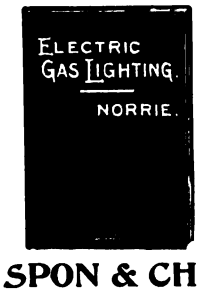
FOR FIVE YEARS A STAPLE SUPPLY.

Requires no leather, canvas or paper. Is complete in itself. Just paint it on a pulley with a brush and it's ready for use in 4 to 6 hours.

DURABLE. ECONOMICAL.

We guarantee it to give satisfaction. You need it. Write for particulars to-day.

The WARREN COMPANY, Inc.
MANUFACTURERS,
253 N. Franklin Street, - Chicago, Ill.



A New Book. Latest American Practice.

ELECTRIC GAS LIGHTING. NORRIE.

Gives Full Instructions

How to install Electric Gas Igniting Apparatus, by H. S. Norrie. Send for full descriptive circulars—free.

Copies mailed, postpaid, on receipt of 50 cts.

SPON & CHAMBERLAIN,
12 Cortlandt St., New York, U. S. A.

THE MASON Reducing Valves

ARE THE WORLD'S STANDARD VALVES

For automatically reducing and absolutely maintaining an even steam or air pressure.

They are adapted for every need and guaranteed to work perfectly in every instance.

Write for full information and splendid references.

THE MASON REGULATOR CO. Boston, Mass., U. S. A.

SOLID TRAINS TO NORTHERN MICHIGAN.

The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

53

THE JOHN CRERAR LIBRARY
NOV 7 1901

IN THIS ISSUE

Isolated Power Plant of a Graphite Factory.
Relative Merits of Open and Enclosed Arc Lamps.
Report of American Street Railway Convention.

VOL. XIII. NOVEMBER, 1901. No. 11.

AMERICAN ELECTRICIAN

A Journal of Practical Electrical and Steam Engineering.

$1.00 per Year. INDEX TO ADVERTISERS, PAGE 9. 10 Cents per Copy.

NEWMAN-SPRANLEY COMPANY, Limited
EVERYTHING ELECTRICAL
NEW ORLEANS, LA., U. S. A.

......THE....
Phoenix Glass Co.,
MANUFACTURERS OF
ELECTRIC AND GAS GLOBES, SHADES, Etc.
Have you a copy of our latest Catalogue? If not, send for it.
Pittsburgh. New York. Chicago.

Holophane Glass Co.
15 East 32d Street, New York,
MANUFACTURERS OF
Compound Prisms, Globes and Shades
For all Kinds of Lights.
GUARANTEED TO GIVE
"Maximum Light, Perfect Diffusion, Minimum Glare."
Send for Catalogues and Price Lists.

W W
Westinghouse
Air Brakes
Electrical Apparatus
Gas and Steam Engines
Incandescent Lamps
W W

Black Diamond File Works
Established 1863. Incorporated 1895,
TRADE MARK.
TWELVE MEDALS AWARDED AT INTERNATIONAL EXPOSITIONS.
SPECIAL PRIZE GOLD MEDAL AT ATLANTA, 1895.
G. & H. BARNETT COMPANY
PHILADELPHIA, PA.

No end of trouble without Rockwood's Patent Compressed **Paper Pulleys.**
Specify them on all contracts and orders.
THE ROCKWOOD MANUFACTURING COMPANY,
Catalogue for asking. P. O. Box 462 (c), Indianapolis, Indiana, U. S. A.

I-T-E CIRCUIT BREAKERS
THE CUTTER CO.
PHILADELPHIA

Packard { Incandescent Lamps and Transformers...
New York & Ohio Co.,
WARREN, OHIO.

DON'T BURN YOUR MONEY IN POOR LAMPS.
SHELBY LAMPS Highest Efficiency, Longest Life, Full C. P. Maintenance { Every Shipment Guaranteed. }
THE SHELBY ELECTRIC CO., Shelby, Ohio.
Write for Catalogue. Special Prices on Trial Orders.

Entered at the New York Post Office as Second-class Matter.

Copyright, 1901, by the AMERICAN ELECTRICIAN COMPANY.

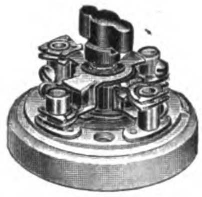
ARE THE

“HART” TRADE MARK Switches

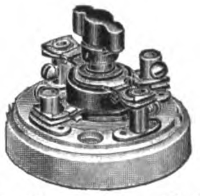
BEST

THE HART STANDARD SWITCH illustrated below is substantially made and of superior design. It conforms to the latest regulations of the Underwriters, the current carrying parts being insulated from the mechanism, and the covers are lined with insulating material on the top and sides. If desired, single and double pole switches can be furnished with indicating dial, which revolves with the movement of the switch, showing instantly whether the current is “ON” or “OFF.” Bases are “open” for cleat work, or “closed” for concealed work.

No. 20. 5 Amp. S. P.
No. 21. 10 Amp. S. P.

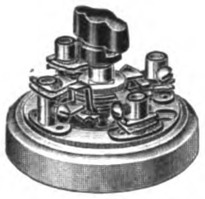


No. 24. 10 Amp. 4-Way.

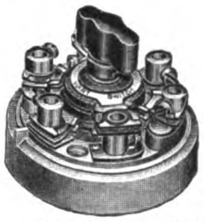


No. 22. 10 Amp. D. P.
No. 32. 20 Amp. D. P.

No. 23. 10 Amp. 3-Way.
No. 33. 20 Amp. 3-Way.
No. 43. 35 Amp. 3-Way.



No. 25. 10 Amp. Electrolier.
No. 29. 10 Amp. Electrolier.



No. 26. 10 Amp. T. P.
No. 36. 20 Amp. T. P.
No. 46. 35 Amp. T. P.

THE
HART AND HEGEMAN
MFG. CO.
52 UNION PLACE HARTFORD, CONN.

ELECTRICAL WIRES AND CABLES.

JOHN A. ROEBLING'S SONS CO.

TRENTON, N. J.

Rail Bonds. **Suspension Strand.**

ABOUT

P AND B

Electrical Compounds

should be waterproof and practically fireproof. P. & B. is proof against these elements. A substitute for shellac and other expensive insulators. 'Tisn't merely a **coating.** It goes right into the pores and preserves anything treated with it. ACID PROOF. DURABLE. ECONOMICAL

THE STANDARD PAINT COMPANY
100 William St., New York

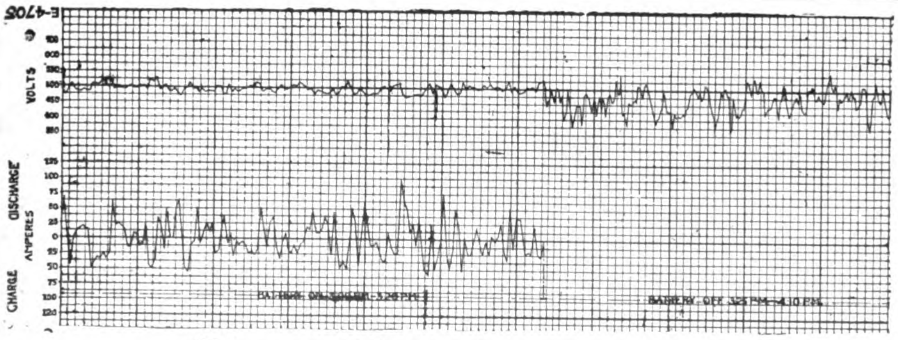
Homer
of
Cleveland

Do you want a special commutator? If you will send us a description, we will make you a sketch and submit price, using the best material the market affords.

We do not attempt to compete with concerns using cheap bars and insulation, and do not, at any time, allow this material to enter into the construction of our Commutators. A strictly high grade Commutator costs a little more in the start, but is the cheapest in the end.

We also make a specialty of making and refilling Stationary Generator and Motor Commutators.

The Homer Commutator Company
CLEVELAND, OHIO



Object Lesson No. 4.

Showing the effect of a battery of

"Chloride Accumulators"

floating on the line.

Note the drop in pressure when battery is off.

Send for Bulletins
describing
Railway
Installations,

THE ELECTRIC STORAGE BATTERY CO.

Allegheny Avenue and 19th Street, Philadelphia, Pa.

SALES OFFICES

NEW YORK:	BOSTON:	CHICAGO:	BALTIMORE:	ST. LOUIS:	CLEVELAND	SAN FRANCISCO:	PHILADELPHIA:	DETROIT:
100 Broadway.	60 State St	Marquette Bldg.	Equitable Bldg.	Wainwright Bldg.	New England Bldg.	Nevada Block.	Allegheny Ave. and 19th St.	Michigan Elec. Co.

B89

FRANK N. PHILLIPS, President. E. ROWLAND PHILLIPS, Vice-President
C. H. WAGENSEIL, Treasurer. C. R. REMINGTON, Jr., Secretary.
EUGENE F. PHILLIPS, General Manager.

AMERICAN ELECTRICAL WORKS,
PROVIDENCE, R. I.

Bare and Insulated Electric Wire,

ELECTRIC LIGHT LINE WIRE;
INCANDESCENT and FLEXIBLE CORDS

Railway Feeder and Trolley Wire,

Americanite, Magnet, Office, and Annunciator Wires.

Cables for Aerial and Underground Use.

NEW YORK STORE: W. J. Watson, 26 Cortlandt St.
CHICAGO STORE: F. E. Donohoe, 52 Lake St.
MONTREAL BRANCH: Eugene F. Phillips' Electrical Works.
MAIN OFFICES AND FACTORIES, Phillipsdale, R. I.

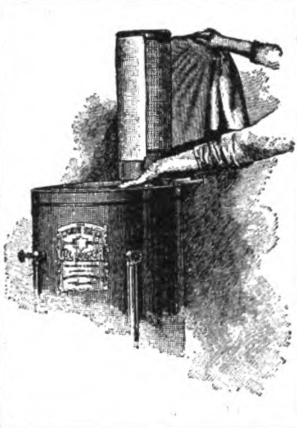
NATIONAL ELECTRICAL CODE STANDARD

WEATHER-PROOF TRADE MARK "O.K." LINE AND HOUSE WIRES

Slow-Burning Weatherproof.
"O. K." Weatherproof and Slow Burning Wire.

Prices and Samples on Application.

PHILLIPS INSULATED WIRE CO.
OFFICE AND FACTORY
PAWTUCKET, R. I.



WHITE STAR OIL FILTER

THE WHITE STAR

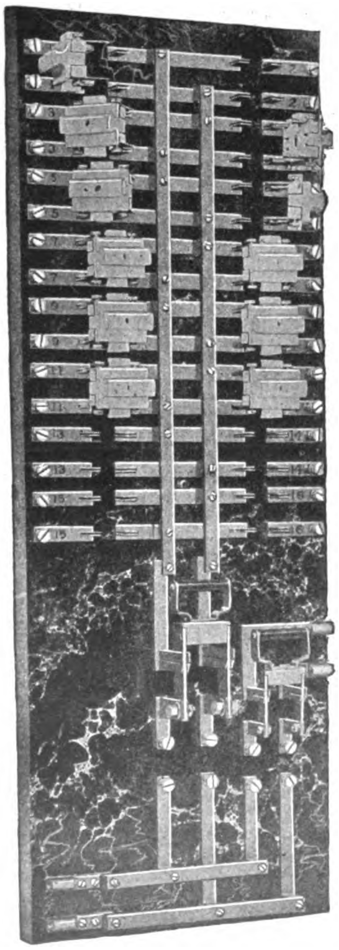
is the only oil filter having filtering material that can be removed, cleaned and used over and over again.

The filter cloth is easily removed from cylinder with one hand, as cylinder revolves. After washing with soapine and water, cloth is ready for use again. No heavy expense for filtering material, as with other filters.

We can demonstrate that the White Star will filter more oil, filter it better, and with less time and expense than any other filter.

Write for booklet, "The White Star," illustrating entire operation, and learn about a scientific and perfect oil filter.

PITTSBURGH GAGE & SUPPLY CO.
310 Water Street, PITTSBURGH, PA.



...THE FAMOUS...

Z & H PANEL BOARDS

Still Lead the Procession.

Designs Always Up-to-Date.
Workmanship and Material of the Highest Grade.

STANDARD AND SPECIAL FORMS
FOR ALL PURPOSES.

CHICAGO;
BADT-GOLTZ
ENG. CO.,
MONADNOCK
BLOCK.

ZIMDARS & HUNT,
Office: 127 Fifth Ave.
Factory: 52-54 Grove St.
NEW YORK.

Every Cross Oil Filter

is sold upon this substantial

GUARANTY:

We know that all material entering into the construction of our Filters is the best that can be secured; also that we employ only skilled workmen.

However, we stand ready at any time to repair at our own expense any defects due to poor material or workmanship. Or, if desired, we will send a new Filter free of charge. Thirty days' trial allowed before purchase. Shall we send one?

THE BURT MFG. CO.,
AKRON, OHIO, U. S. A.

Largest Mfrs. of Oil Filters in the World. | WE ALSO MAKE THE BURT EXHAUST HEAD.

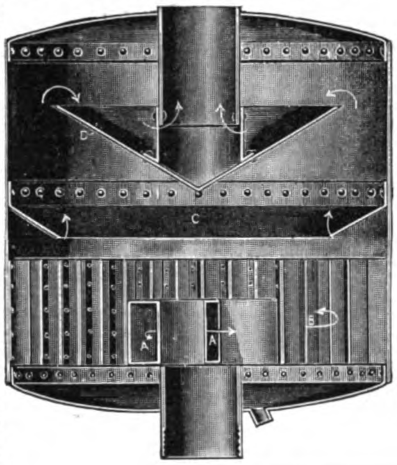
MAKES A WET JOB DRY.

Newgard Combined Waterproof Globe and Receptacle.

No socket or other attachment necessary. Strong, durable and the only article of its kind that is an absolute protection to the lamp. Send for special circulars showing the three different styles.

ELECTRIC APPLIANCE COMPANY,
CHICAGO.

SIMS' EXHAUST HEAD



Large condensing area. Ample room for expansion of steam, relieving engine of back pressure. Made of heavy galvanized sheet iron with lap rivets, joints thoroughly soldered. No parts to leak or wear out. Send for circular and price list.

SIMS COMPANY,
ERIE, PENNA.

SYRACUSE, N. Y., Oct. 14, 1901.

THE SIMS CO.,
ERIE, PA.

Gentlemen:—The 2½ Exhaust Head, bought of you, we have had in use for some time, and it works very satisfactory indeed. It is attached to an exhaust pipe of about 100 feet horizontal, and then carried vertically about 40 feet to top of building. We cannot detect any moisture from it on the roof, and we think it the best of any that we have had occasion to use, and we have placed several other makes in use, in fact, took off one which we replaced by yours.

Yours truly,
BOGGS & CLARKE.

THE LARGEST AND STRONGEST BUSHING MADE.

NEW ENGLAND ELEC. MFG. CO.

Takes a Number 16 new code lamp cord. **No thread**—the Bushing is **permanently attached** to the socket shell. We can furnish any make of key or keyless socket with this Bushing attached.

☞ **OUR OWN new type EDISON or T.-H. SOCKETS** are guaranteed to carry 25 per cent. more current than any other.

New England Electric Mfg. Co.
BOSTON, MASS.

Chemicals for Steam Boilers : : :

GEO. W. LORD,
2238 to 2250 North 9th St.,
PHILADELPHIA.

Many Subscribers to AMERICAN ELECTRICIAN may wonder why Chemicals should be used in their Boilers.

We will endeavor to explain: All Feed-waters carry substances in suspension and solution which do not pass off with Steam and necessarily remain and accumulate in the Boiler.

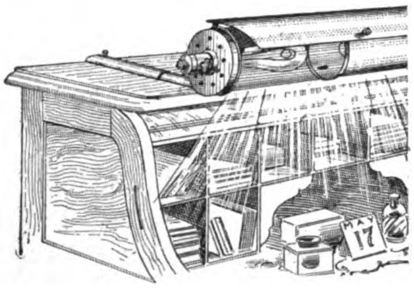
This accumulation forms a coating, or scale, which not only causes great waste of fuel, but may increase to such an extent that the Boilers are placed in dangerous condition.

To prevent and remove this scale has been our business for the past 35 years, and we have been so successful that our Chemicals, known as "LORD'S BOILER COMPOUNDS," are recognized as the world's standard.

ALL GOODS ARE COMPOUNDED SPECIALLY FOR EACH CUSTOMER.

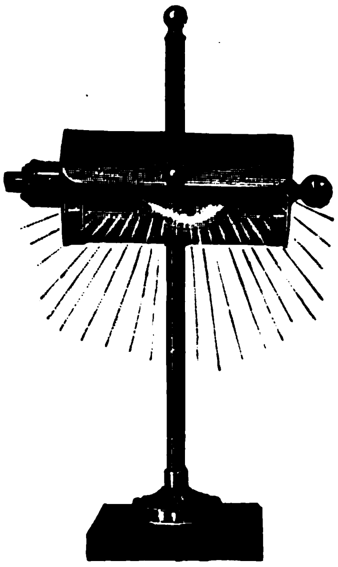
Send us sample of Boiler Scale. We will analyze it free of charge and make a full report.

SAVE YOUR EYES.

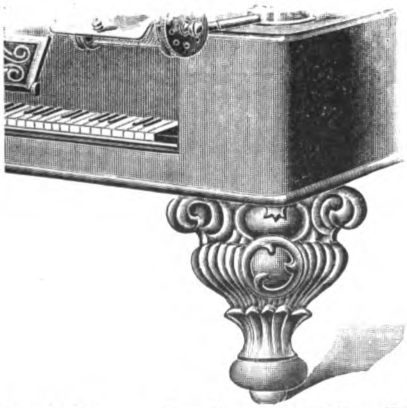


No. 6, Kinsman Double Cylinder Desk Lamp, finished in polished brass, nickel-plate, oxidized copper or old brass.

No. 8, Kinsman Portable, finished in polished brass, nickel-plate, oxidized copper or old brass.



No. 5, Kinsman Portable, finished in polished brass, nickel-plate, oxidized copper or old brass.



No. 9, Kinsman Portable, finished in polished brass, nickel-plate, old brass or oxidized copper.

The above illustrations represent some of the Kinsman fixtures. We will be pleased to mail you pocket catalogue and quote prices on request.
Beware of Spurious Imitations.

McLEOD, WARD & CO.,
26 THAMES ST., NEW YORK.

OUR NEW

TRADE **G. I.** MARK.

Direct Current C. P.

ARC LAMP

IS THE BEST
AND CHEAPEST

Arc Lamp in the business

Send for Bulletin No. 172

GENERAL INCANDESCENT ARC LIGHT CO.

Factory and General Offices: 572-578 FIRST AVE., NEW YORK
Cable Address: "INSULL," N. Y.
CHICAGO, DENVER, ST. LOUIS, CINCINNATI, CLEVELAND, BOSTON.

AMERICAN
STORAGE CELLS ARE THE BEST
SEND FOR DESCRIPTIVE CIRCULAR
AMERICAN BATTERY CO.
169 So. Clinton St., Chicago, Ill.
ESTABLISHED 1889

ANDERSON & SONS,
21 to 31 St. Aubin Ave., Detroit, Mich.
Digging Sets, Arm Braces, Guy Rods, Pole Steps, Etc., Etc.
Tools and Iron Work for
TELEPHONE AND RAILWAY CONSTRUCTION.

R. LESTER THAYER,
Consulting Electrical Engineer,
Machinery,
Long Dist. Tel. 377. PEORIA, ILLINOIS.

MICHIGAN COLLEGE OF MINES.

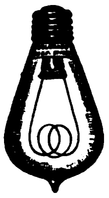
An Engineering School with unique location, giving it unusual facilities. Distinctive methods of instruction. Special courses given. All work in charge of widely experienced men. Catalogue giving list of graduates and their occupations on application. Address

F. W. McNAIR, President,
Houghton, Michigan.

"Knowledge is Power."

Hawkins' Educational Works on stationary engineering—sold on easy monthly terms of payment. Send for description of books and terms.

THEO. AUDEL & CO.,
63 FIFTH AVE., NEW YORK CITY.

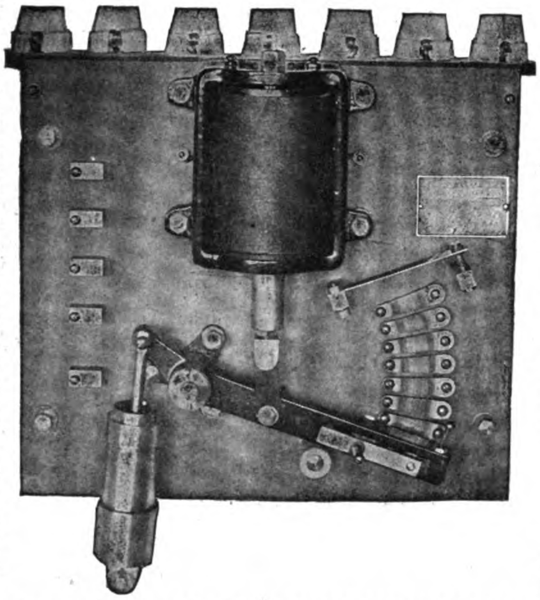


THE KNOW HOW.
We have it and you get the results.
. . . THE . . .
COLORADO LAMP CO.,
DENVER.

Switchboards, Slate and Marble, Electric Slate. . **McNAMARA BROS.,** Fair Haven, Vt.

The American Electrician has the largest paid circulation of any electrical journal in the World.

C. & H. SELF-STARTERS



For operating electric elevators and motor-driven pumps are compact, thoroughly ventilated and extremely easy to install. They are free from complications and are absolutely reliable. Write for descriptive bulletin 565 and prices.

THE
CUTLER-HAMMER MFG. CO.
MILWAUKEE, WIS.
WESTFIELD, N. J.
NEW YORK, N. Y.

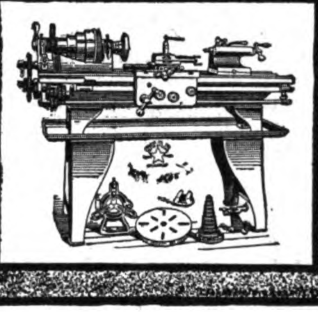
The largest and oldest exclusive manufacturers of Electric Controlling Devices in the world.

13 in "STAR" LATHE for the Tool Room

A new tool, of improved design and exclusive features, particularly adapted for Tool Room use Thoroughly **modern** in **construction** and built for the **most accurate** and **exacting service.**

Furnished with Plain, Compound or Raise and Fall Rests; U.S. Standard, Whitworth or Metric Lead Screws, also Drawing-in Chuck and Taper Attachment. Send for catalog "B."

SENECA FALLS MFG. CO.,
424 Water St., Seneca Falls, New York



A Neat Workman

UNION
MADE

LOOK for the Union Label on the lapel of Coat.

KEYSTONE UNION MADE OVERALLS AND PANTS REG'D TRADE MARK

Keystone Overalls are Union Made—ask for them.

A NEAT WORKMAN IS A GOOD WORKMAN. CARE IN DRESS INDICATES CARE IN WORK.

Keystone Overalls

ARE THE NEATEST, CLEANEST AND MOST SERVICEABLE WORKMAN'S DRESS. MADE IN PURE INDIGO BLUES. EASY IN WEAR. FULL CUT. EVERY PART GUARANTEED. BE SURE TO ASK FOR

KEYSTONE OVERALLS

REG'D. TRADE-MARK

CLEVELAND & WHITEHILL Co NEWBURGH N.Y.

WARD LEONARD FIELD RHEOSTATS

The only Gold Medal Field Rheostat in the World

The Standard of the World for the past 8 years.

Imitated by every Rheostat maker in the World, but never equalled.

We sell more Field Rheostats in a month than any other maker of Field Rheostats sells in a year.

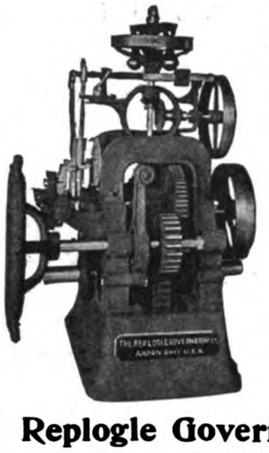
Investigate our recent improvements.

WARD LEONARD ELECTRIC CO.
BRONXVILLE, N. Y., U. S. A.

Comprehensive stock always carried by

Badt-Goltz Eng. Co.,
Monadnock Block,
Chicago, Ill.

Geipel & Lange,
Parliament Mansions.
Westminster,
London, S.W.



REPLOGLE GOVERNORS

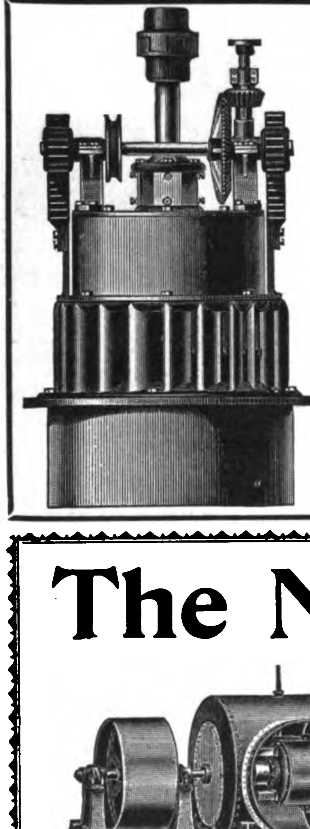
For Governing Water Power for
Textile and Paper Mills and Electric Light, Power and Railway Work.

Send for Descriptive Circular.

Replogle Governor Works, Akron, Ohio.

Pamphlet containing full information, with illustrations of all styles of Turbine Wheels, Tables, Etc., sent on application.

ESTABLISHED 1862
CHRISTIANA MACHINE COMPANY
CHRISTIANA, PENN. U.S.A.
ENGINEERS, FOUNDERS & MACHINISTS.
MFR'S OF
TURBINE WATER WHEELS.
ADAPTED TO ALL DUTIES
POWER TRANSMITTING MACHINERY.
GEARING ROPE WHEELS, FRICTION CLUTCHES
SHAFTING, PULLEYS, HANGERS &c



THE McCORMICK TURBINE

Features Worth Consideration.

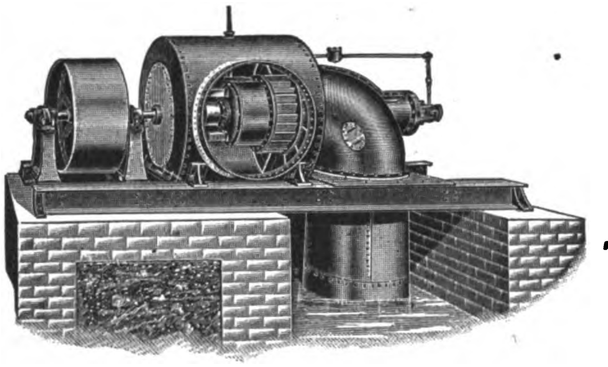
Great Capacity, High Speed, Unequalled Efficiency, Steady Motion, Easy Working Gate, Greatest Power from a Limited Quantity of Water, at Smallest Cost.

UNDOUBTEDLY THE MOST POPULAR TURBINE MANUFACTURED.

Write for Catalogue.

S. MORGAN SMITH COMPANY,
York, Pa., U. S. A.

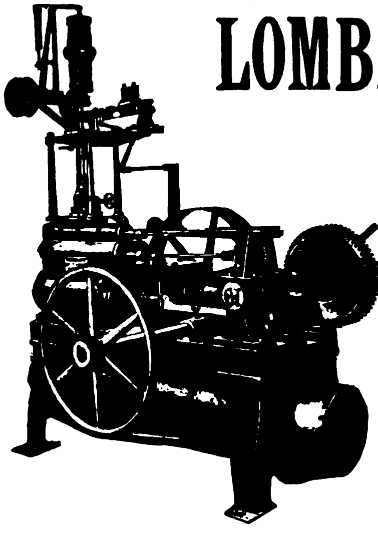
The New American Turbine



FOR ELECTRIC POWER.

State Your Requirements.
Send for Catalogue. . .

The Dayton Globe Iron Works Co.
100 LUDLOW STREET, DAYTON, OHIO.



LOMBARD WATER WHEEL GOVERNORS

are guaranteed to give a more accurate speed regulation than any other make of governor. **300,000** horse power in use. Write for descriptive printed matter and list of plants where used.

THE LOMBARD GOVERNOR CO.,
36 Whittier Street, Boston, Mass.

Index to Advertisers.

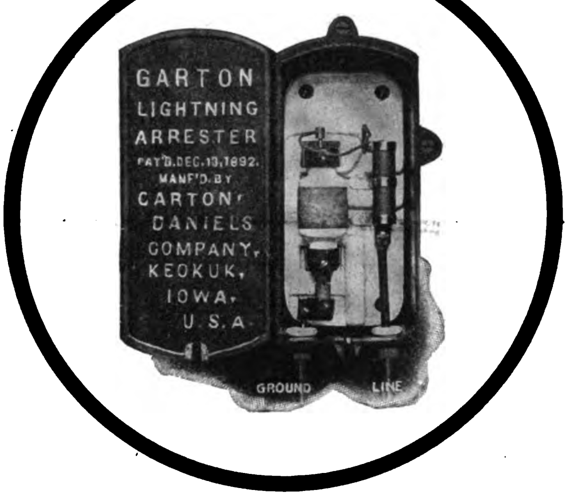
Akron Elec. Mfg. Co., Akron, O............ 56
Albany Steam Trap Co., Albany, N. Y.... 61
Alden Electrical Co., Chicago, Ill.......... 58
American Battery Co., Chicago............. 6
Am. District Steam Co., Lockport, N. Y... 71
Am. Elec. & Maintenance Co., New York.. 33
American Elec. Fuse Co., Chicago.......... 29
Amer. Elec. Htr. Co., Detroit, Mich........ 16
Amer. Elec. Works, Providence, R. I...... 4
Amer. Eng. Co., Bound Brook, N. J...... 67
Amer. Min. & Dec. Lamp Co., N. Y........ 26
Amer. Reflector & Lighting Co., Chicago.. 31
Amer. School of Correspondence, Boston... 43
Amer. Steel & Wire Co., Chicago.......... 41
American Workingman's Protective Association, Detroit, Mich....................... 64
Anchor Chemical Co., Brooklyn, N. Y...... 39
Anderson & Sons, Detroit, Mich............ 6
Anderson Tool Works, Anderson, Ind...... 24
Arnold Elec. Power Station Co., Chicago.. 11
Audel, Theo., & Co., New York..........6, 37
Austin Separator Co., Detroit.............. 60

Babcock & Wilcox Co., New York.......... 63
Baillard, E. V., New York.................... 19
Baker & Co., Newark, N. J................. 35
Baker & Fox, Brooklyn, N. Y............... 26
Ball Engine Co., Erie, Pa................... 69
Ball & Wood Co., New York................. 69
Banner Electric Co., Youngstown, O....... 27
Barkelew Elec. Mfg. Co., Middletown, O.. 15
Barnes Co., Wallace, Bristol, Conn........ 37
Barnett Co., G. & H., Philadelphia, Pa.... 1
Bartz, Evans & Wygants, Hornellsville.... 52
Baum Separator Co., Reading, Pa.......... 71
Beggs, Jas., & Co., New York................ 62
Belknap Motor Co., Portland, Me........... 51
Bernard, E. G., Co., Troy, N. Y............. 56
Biddle, J. G., Philadelphia, Pa.............. 11
Bossert Elec. Con. Co., Utica, N. Y........ 17
Bourse, The, Philadelphia 58
Bristol Co., The, Waterbury, Conn.......... 72
Bruce-Hibbard Elec. Co., Fitchburg, Mass. 38
Bullock Elec. Mfg. Co., Cincinnati, O...... 53
Burt Manufacturing Co., Akron, O.......... 5

C & C Electric Co., New York................ 55
Carhartt, Hamilton, Detroit, Mich......... 64
Cary Spring Works, New York............... 58
Central Elec. Co., Chicago.................... 23
Central Mfg. Co., Chattanooga, Tenn...... 38
Century Telephone Cons. Co., Cleveland, O. 46
Chase-Shawmut Co., Boston, Mass.......... 30
Chicago Rawhide Mfg. Co., Chicago........ 70
Christiana Machine Co., Christiana, Pa.... 8
Clarke Automatic Scales Co., N. Y........ 67
Clayton & Lambert, Detroit, Mich.......... 72
Cleveland & Whitehill Co., Newburg, N.Y. 7
Cling-Surface Mfg. Co., Buffalo, N. Y...... 59
Collyer Insulated Wire Co., Pawtucket, R. I. 72
Colonial Elec. Co., Ravenna, O............... 29
Colorado Lamp Co., Denver, Colo.......... 6
Columbus Mach. Co., Columbus, O.......... 66
Commercial Elec. Co., Indianapolis.......... 56
Conover Mfg. Co., New York................ 68
Consolidated Schools, N. Y.................... 43
Cooper, The C. & G., Co., Mt. Vernon, O.. 69
Cream Flux Co., Chicago..................... 35
Crocker-Wheeler Co., Ampere, N. J........ 52
Croslen Mfg. Co., Chicago, Ill.............. 70
Crouse-Hinds Elec. Co., Syracuse, N. Y... 21
Cutler-Hammer Mfg. Co., Milwaukee...... 7
Cutter Co., The, Philadelphia, Pa............ 1

D. & W. Fuse Co., Providence, R. I........ 46
Darling Pump & Mfg. Co., W'msport, Pa.. 62
Dayton Globe Iron Wks., Dayton, O....... 8
Dearborn Drug & Chem. Works, Chicago.. 62
Diamond Meter Co., Peoria, Ill.............. 50
Dixon, Jos., Crucible Co., Jersey City...... 14
Dunn-Martin Elec. Co., N. Y.............. 38

Economy Electric Co., Warren, O.......... 27
Eddy Elec. Mfg. Co., Windsor, Conn...... 57
Eldredge Elec. Mfg. Co., Springfield, Mass. 50
Electric Appliance Co., Chicago, Ill........ 5
Elec. Gas. Lighting Co., Boston, Mass.... 17
Elec. Motor & Equip. Co., Newark, N. J.. 23



IN THE CIRCLE

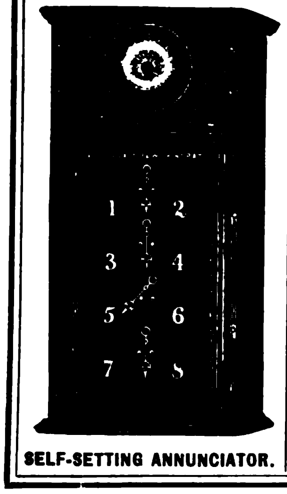
of your acquaintances you will find none more reliable in time of need than

Garton Lightning Arresters

They are always ready, offering the discharge the lowest possible resistance to ground.

Made for direct and alternating current in many styles. Send for Pamphlet No. 28.

GARTON-DANIELS COMPANY,
KEOKUK, IOWA.



SELF-SETTING ANNUNCIATOR.

ANNUNCIATORS, BELLS AND
OTHER ELECTRICAL SUPPLIES

For **Hotel, House, Office, Store** and **Factory Work.**

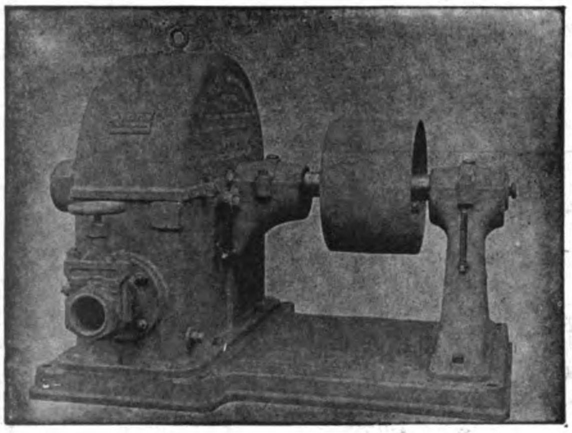
Catalogs on Application. All Inquiries Cheerfully Answered.

Leading Supply Dealers Everywhere Carry Our Goods in Stock

Office and
Factory
1231-1239 Callowhill St.

PARTRICK, CARTER & WILKINS,
Manufacturers,
PHILADELPHIA, PA.

THE PELTON WATER WHEEL



Is known the world over as affording the most simple, reliable and economical power for all purposes.

Ten Thousand Wheels now Running

Filling every condition of service in the most efficient and satisfactory way.

Electric Power Transmission

PELTON WHEELS are the recognized standard for operating Generators, and are running the majority of stations of this character in all parts of the world.

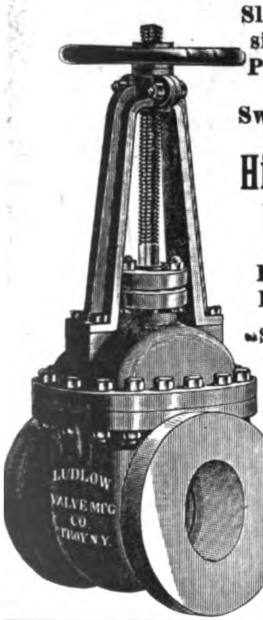
Water Pipe and Transmission Machinery,

And all appliances connected with a power plant, supplied on the most reasonable terms. Shipments made from San Francisco or New York—as may afford the most favorable freight rates. Catalogues, English or Spanish, furnished on application. Address, giving conditions of service,

THE PELTON WATER WHEEL CO.,
125 Main St., San Francisco, Cal., U. S. A.
143 Liberty St., New York, N. Y., U. S. A.

The Ludlow Valve Mfg. Co.

TROY, N. Y., U. S. A.



Slide Gate Valves of every size and style. For all Pressures and Purposes.

Swinging Check Valves.

High Pressure Steam Valves A SPECIALTY

Everybody wants Reliable Valves.

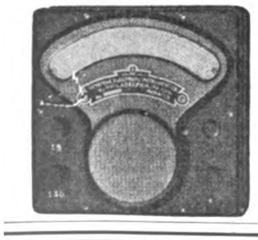
Specify and insist upon having the

" LUDLOW."

Our name appears on every valve we make and means

STANDARD OF MERIT.

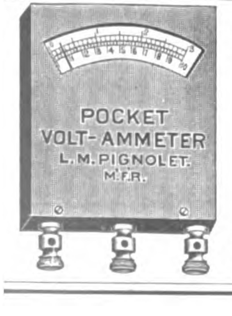
..Keystone Portable Voltmeters..



FOR DIRECT CURRENT CIRCUITS.

These instruments are constructed on the principle of the Deprez-d'Arsonval galvanometer, are of extremely high sensibility, and are all carefully calibrated. *Send for Catalogue XI.*

Keystone Electrical Instrument Co.,
9th St. and Montgomery Ave., - - - - PHILADELPHIA, PA.
NEW YORK, 15 Cortlandt St. BOSTON, 170 Summer St. CHICAGO, 613 Manhattan Bldg.


POCKET
VOLT-AMMETER
L. M. PIGNOLET.
M'F'R.

Electric Instruments.

POCKET SIZE. VARIOUS RANGES.

For Continuous Current Measurements. Testing Batteries, Circuits, Etc. All Instruments are three times size of cut.

RELIABLE. ACCURATE.

Send for Circular

L. M. PIGNOLET, 80 Cortlandt Street, New York, N. Y.

Elec. Storage Battery Co., Phila. Pa...... 8
Electrical Engineer Institute of Corres. Instruction, N. Y. 43
Emerson Elec. Mfg. Co., St. Louis, Mo.... 52
Engberg's Elec. & Mech. Wks., St. Joseph, Mich. 52
Ericsson Tel. Co., New York........ 35

Fagan, J. C., Watertown, N. Y........ 22
Faries Mfg. Co., Decatur, Ill........ 31
Farr Tel. & Cons. Supply Co., Chicago.... 46
Filer & Stowell Co., Milwaukee, Wis...... 65
Frink, I. P., New York........ 31
Fuller Co., Detroit, Mich........ 70

G. & E. Electric Co., Binghamton, N. Y... 39
Garl Electric Co., Akron, O........ 44
Garton-Daniels Co., Keokuk, Ia........ 9
General Electric Co., Schenectady, N. Y.. 32
General Incandescent Arc Light Co., N. Y. 6
Gordon Battery Co., N. Y........ 48
Gould Storage Battery Co., N. Y........ 19

Halsey, Edw. S., Chicago, Ill........ 51
Hamblin, J. A. Providence, R. I........ 31
Harrisburg F. & Mach. Wks., Harrisburg. 68
Harrison Safety Boiler Wks., Philadelphia 61
Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn........ 37
Hart & Hegeman Mfg. Co., Hartford...... 2
Hart Mfg. Co., Hartford, Conn........ 30
Hazelton Boiler Co., New York........ 63
Heck, Louis, Newark, N. J........ 38
Heine Safety Boiler Co., St. Louis, Mo.... 63
Hewitt & Warden, Newburg, N. Y........ 19
Hill Elec. Co., New Bedford, Mass........ 22
Hobart Elec. Mfg. Co., Troy, O........ 66
Hoffman, G. W., Indianapolis, Ind........ 37
Holophane Glass Co., N. Y........ 1
Holtzer-Cabot Elec. Co., Boston, Mass.... 53
Homer Commutator Co., Cleveland, O...... 8
Hoppes Mfg. Co., Springfield, O........ 60
Horn & Brannen Mfg. Co., Philadelphia.. 16
Hudson Porcelain Works, N. Y........ 20
Humphrey, H. H., St. Louis........ 16

Int. Corres. Schools, Scranton, Pa........ 42

Jeffrey Mfg. Co., Columbus, O........ 58
Johns, H. W., Mfg. Co., N. Y........ 11

K. & W. Company, Pittsfield, Mass........ 52
Keasbey, R. A., New York........ 63
Kellogg Sw'chb'd & Sup. Co., Chicago..19, 47
Kentucky Elec. Co., Owensboro, Ky........ 24
Keystone Elec. Instr. Co., Phila., Pa...... 10
Klein, Mathias, & Son, Chicago, Ill........ 58
Knott, L. E., Apparatus Co., Boston...... 51
Kuhlman Elec. Co., Elkhart, Ind........ 20

Lagonda Mfg. Co., Springfield, O........ 62
Leclanche Battery Co., New York........ 72
Leffel, James & Co., Springfield, O......16, 68
Le Valley Carbon Brush Co., N. Y........ 14
Linton, G. E., & Co., Worcester, Mass.... 22
Lombard Governor Co., Boston, Mass..... 8
Lord, Geo. W., Philadelphia, Pa........ 5
Ludlow Valve Mfg. Co., Troy, N. Y........ 10

Machado & Roller, New York........ 11
Manhattan Elec. Sup. Co., New York...22, 44
Manhattan Gen. Const. Co., Newark, N. J 25
Manross, F. N., Forestville, Conn........ 58
Marshall-Sanders Co., Boston, Mass........ 16
Mason Regulator Co., Boston, Mass........ 36
McCrea, James & Co., Chicago, Ill........ 62
McIntosh, Seymour & Co., Auburn, N. Y. 65
McLennan, K., & Co., Chicago, Ill........564
McLeod, Ward & Co., N. Y........ 6
McNamara Bros., Fairhaven, Vt........ 6
Meier's Sons, Newark, N. J........ 72
Mica Insulator Co., New York........ 33
Michigan Col. of Mines, Houghton, Mich. 6
Mietz, A., New York........ 15
Moloney Elec. Co., St. Louis........ 20
Morse Twist Drill & Mach. Co., New Bedford, Mass. 72
Mound Tool & Scraper Co., St. Louis...... 68
Munsell, Eugene, & Co., New York........ 33
Murray, J. J. & Co., Philadelphia........ 31
Murray Iron Works, Burlington, Ia........ 68

New Britain Mach. Co., N. Britain, Conn. 72
New England Elec. Mfg. Co., Boston, Mass. 5
New England Motor Co., Lowell, Mass..... 52
New Excelsior Dry Battery Mftry., N. Y.. 46
Newman-Spranley Co., Ltd., New Orleans. 1
New Process Rawhide Co., Syracuse........ 59
New York & Ohio Co., Warren, O........ 1
New York Telephone Co., N. Y........ 35
North Elec. Co., Cleveland........ 48
Norton Elec. Inst. Co., Manchester, Conn. 11

O. K. Elec. Specialty Mfg. Co., Garrettsville, O. 17
Okonite Co., Ltd., New York........ 72

Palmer Bros., Miamus, Conn........ 66
Parsell & Weed, New York........ 51
Partrick, Carter & Wilkins, Phila., Pa.... 9
Pelton Water Wheel Co., San Francisco.. 10
Penn. Elec. & Ry. Sup. Co., Pittsburg.... 39
Phelps Co., Detroit, Mich........ 26
Phillips, Eugene F., Providence, R. I........ 4
Phillips Ins. Wire Co., Pawtucket, R. I.... 4
Phoenix Auto. Filter Co., Racine, Wis.... 14
Phoenix Glass Co., New York........ 1
Pierce, Frank M., Eng. Co., N. Y........ 65
Pignolet, L. M., New York........ 10
Pittsburg Elec. Lamp Co., Braddock, Pa.. 24
Pittsburg Gage & Sup. Co., Pittsburg, Pa.. 4

Pittsburg Transformer Co., Pittsburg, Pa. 20
Portland Co., Portland, Me. 50
Protectorate Co., Chicago, Ill. 46
Providence Engineering Wks., Providence, R. I. 67

Quaker City Rubber Co., Philadelphia 59
Queen & Co., Philadelphia, Pa. 13
Quincy Engine Works, Quincy, Ill. 69

Racine Hardware Co., Racine, Wis. 66
Reidy, J. J., & Co., New Haven, Conn. 37
Reisinger, Hugo, New York 15
Reliance Elec. Co., Milwaukee, Wis. 53
Replogle Governor Works, Akron, O. 8
Robbins & Myers Co., Springfield, O. 51
Roberts Elec. Supply Co., Philadelphia 12
Robertson, James L., & Son, New York 37
Rockwood Mfg. Co., Indianapolis, Ind. 1
Roebling's Sons Co., Trenton, N. J. 3
Roche, William, New York 17
Rossiter, MacGovern & Co., New York 38
Roth Bros. & Co., Chicago, Ill. 51

Sage, F. B., & Bros., N. Y. 72
Sawyer-Man Elec. Co., Allegheny, Pa. 1, 34
Schmidt, The Lambert, Tel. Mfg. Co., N. Y. 48
Science and Industry, Scranton, Pa. 58
Seneca Falls Mfg. Co., Seneca Falls, N. Y. 7
Shelby Elec. Co., Shelby, O. 1
Shultz Belting Co., St. Louis 72
Signaloid Chemical Wks., Jersey City, N. J. 24
Simplex Electrical Co., Boston, Mass. 22
Sims Co., Erie, Pa. 5
Skinner Engine Co., Erie, Pa. 68
Smith & Hemenway Co., N. Y. 35
Smith, A. L., & Co., Philadelphia, Pa. 61
Smith, S. Morgan, Co., York, Pa. 8
Southwark Foundry & Mach. Co., Phila. 65
Southworth & Hare, Indianapolis, Ind. 35
Spon & Chamberlain, N. Y. 36
Sprague Elec. Co., New York 49
Stand. Auto. Gas Eng. Co., Oil City, Pa. 66
Standard Paint Co., New York 3
Stand. Underground Cable Co., Pittsburg. 16
Stanley Instr. Co., Gt. Barrington, Mass. 33
Stephenson Mfg. Co., Albany, N. Y. 59
Sterling Electrical Mfg. Co., Warren. O. 28
Sterling Varnish Co., Pittsburg, Pa. 37
Steward, D. M., Chattanooga, Tenn. 14
Stewart Elec. Co., Cincinnati, O. 38
Stewart Heater Co., Buffalo, N. Y. 60
Stilwell-Bierce & S.-V. Co., Dayton, O. 33
Stirling Co., New York and Chicago 63
St. Louis Iron & Mach. Wks., St. Louis. 65
Stocker, Geo. J., St. Louis, Mo. 60
Stromberg-Carlson Tele. Co., Chicago 45
Stucky, Jacob, Newark, N. J. 38
Sturtevant, B. F., Co., Boston, Mass. 14

Telephone Co. of America, Wash., D. C. 46
Thayer, R. Lester, Peoria, Ill. 6
Thresher Electric Co., Dayton, O. 54
Toerring Co., C. J., Philadelphia 12
Triumph Elec. Co., Cincinnati, O. 57
Tulley, H. C., & Co., St. Louis 58

U. S. Elec. Contract. Co., Syracuse, N. Y. 52
U. S. Mineral Wool Co., New York 66

Van Dorn-Elliott Elec. Co., Cleveland 39
Van Nostrand Co., D., New York 18
Varley Dup. Mag. Co., Phillipsdale, R. I. 46
Vilter Mfg. Co., Milwaukee, Wis. 66
Vindex Electric Co., Chicago 21

Wagner Elec. Mfg. Co., St. Louis, Mo. 53
Ward Leonard Elec. Co., Bronxville, N. Y. 7
Warren Co., Inc., Chicago 71
Warren Elec. & Spec. Co., Warren, O. 21, 25
Warren Elec. Mfg. Co., Sandusky, O. 55
Western Elec. Co., Chicago and N. Y. 19
Western Elec. Supply Co., St. Louis, Mo. 24
Westinghouse Air Brake Co., Pittsburg. 1, 34
Westinghouse, Church, Kerr & Co., N.Y. 1, 34
Westinghouse Elec. & Mfg. Co. 1, 34
Westinghouse Mach. Co., Pittsburg 1, 34
Weston Elec. Inst. Co., Waverly Park, N.J. 50
White Co., O. C., Worcester, Mass. 31
White Co., The H. P., Ltd., Philadelphia 22
White, D. M., Co., S. S., Phila., Pa. 48
Whitney Elec. Inst. Co., Penacook, N. H. 11
Willyoung, E. G., New York 11
Wirt Elec. Co., The, Philadelphia 57
Wright Mfg. Co., Detroit, Mich. 61

Zeller, Geo. A., St. Louis, Mo. 38
Zimdars & Hunt, New York 4

THE ARNOLD ELECTRIC POWER STATION CO.,

Engineers and Contractors.

Designers and Builders of Complete Electric Properties.

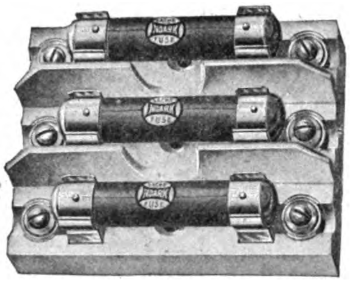
Manufacturers of the Arnold Magnetic Clutch.

Owners of Patents covering the "Arnold System" of Power Station Construction.

Suite 1540 Marquette Building, Chicago.

SACHS "NOARK"

ENCLOSED INDICATING FUSE



FOR ALL VOLTAGES.

PERMANENTLY ACCURATE.

H. W. JOHNS M'F'G CO.,

100 WILLIAM STREET,
NEW YORK.

Boston
Philadelphia
Columbus

Pittsburgh
Chicago
London

CATALOGUE B

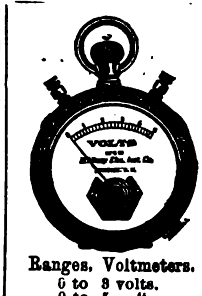
describes a great variety of Ammeters, Voltmeters, Galvanometers, Wheatstone Bridges, Photometers and other Electrical Measuring Instruments.

A specialty of cable testing outfits, portable testing sets, potentiometers, conductivity bridges, etc.

Mailed Free if this ad. is mentioned.

JAMES G. BIDDLE, 1026 Stephen Girard Bldg., PHILADELPHIA.

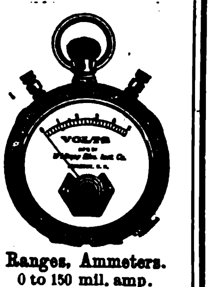
"Jagabi" Portable Testing Set.



The Pocket

Measuring Instruments

of the WHITNEY manufacture are thoroughly accurate and reliable, being built on exactly the same principle as their standard portable meters. The hardened steel pivots of the moving part rest in jewel bearings and the permanent magnets are hardened and aged by the most approved methods. Do not confuse them with common battery gauges.



Ranges, Voltmeters.
0 to 8 volts.
0 to 5 "
0 to 10 "
0 to 15 "

MACHADO & ROLLER,
203 Broadway, New York, N. Y.

General Sales Office of Whitney Electrical Inst. Co.

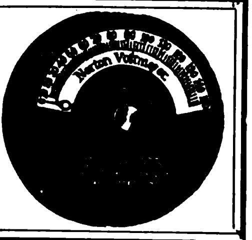
Ranges, Ammeters.
0 to 150 mil. amp.
0 to 1 amperes.
0 to 2 "
0 to 5 "

NORTON Ammeters and Voltmeters

High-Grade Instruments at Moderate Cost.
Write for Circular and Price List.

The Norton Electrical Instrument Co., Main Office and Factory MANCHESTER, CONN.

Agents.—Kohler Bros., Chicago, Ill.; Newman-Spranley Co., New Orleans, La.



MODEL K
OF THE
"AONE" Portab'e Test Set
NOW READY.
For detailed description, diagrams of tests, etc.,

WRITE FOR CATALOGUE 500A—FREE

Measures Resistance, Conductivity, Insulation, Self-Induction, Calibrates Ammeters and Voltmeters, Locates Faults by Loop Tests, Etc., Etc.

Test Instruments

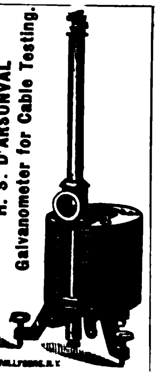
FOR ALL CLASSES OF

Electrical Measurement

Among New Apparatus may be mentioned our "**Short Core**" **Portable X-Ray Machines; No. 1 Station Photometer; two new Potentiometers; The Cunningham Mercury Jet Interrupter, Etc., Etc.**

GET ON OUR MAILING LIST. WE DISTRIBUTE MANY CATALOGUES

ELMER G. WILLYOUNG, 12 & 14 Frankfort St., New York



H. S. D'ARSONVAL Galvanometer for Cable Testing.

WILLYOUNG, N. Y.

If you were to purchase

the opinion of such men as were Judges at the Pan-American Exposition in their capacity as consulting engineers you would have to pay a big fee.

It will cost you nothing

to obtain their opinion about arc lamps. They awarded us the highest honors at

The Philadelphia Export Exposition,
1899.

The Paris Exposition,
1900.

The Pan-American Exposition,
1901.

C. J. TOERRING CO.,

1035 Ridge Ave.,
PHILADELPHIA.

New York Office: 39 Cortlandt Street.

Electrical Supplies

The Best Goods At Fair Prices

A. B. Arc Lamps
Incandescent Lamps
X Arm Braces

Pole Steps
Machine Bolts
Guy Wire

Iron Brackets
Wood Brackets
Insulators

Locust Pins
X Arms
Line Wire

Trolley Wire
Trolley Brackets
Rubber Wire

Cables
Conduits
Sockets and Receptacles

Flexible Cords
Wire Connectors
Street Hoods

Lightning Arrestors
Switch Boards
Instruments

Electricians' Tools
Contractors' Tools

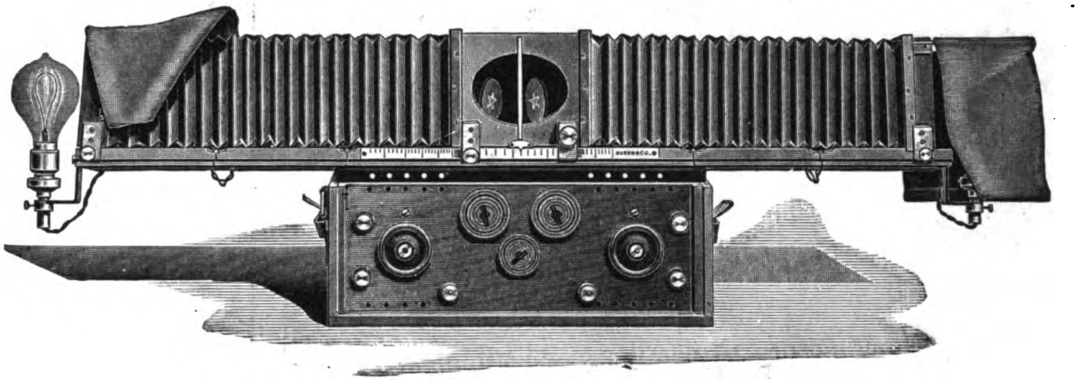
H. C. Roberts Electric Supply Co.,

831 Arch St.,
Philadelphia, Pa.

CLASSIFIED LIST OF ADVERTISERS.

AIR BRAKES.
Westinghouse Air Brake Co., Pittsburgh.
ANCHOR RODS
Anderson & Sons, Detroit.
ANNUNCIATORS.
Elec. Appliance Co., Chicago.
Elec. Gas Lighting Co., Boston.
Partrick, Carter & Wilkins, Phila.
Western Elec. Co., Chicago.
BATTERIES.
American Battery Co., Chicago.
Electric Appliance Co., Chicago, Ill.
Electric Gas Lighting Co., Boston, Mass.
Electric Storage Battery Co., Philadelphia.
Gordon Battery Co., New York.
Gould Storage Battery Co., N. Y.
Leclanche Battery Co., New York.
Manhattan Electrical Supply Co., N. Y.
New Excelsior Dry Battery Co., N. Y.
Partrick, Carter & Wilkins, Phila.
Roche, Wm., New York.
White, S. S., D. M. Co., Phila.
BELLS.
Electric Appliance Co., Chicago, Ill.
Manhattan Electrical Supply Co., N. Y.
Partrick, Carter & Wilkins, Phila.
BELT DRESSING.
Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Jersey City, N. J.
Stephenson Mfg. Co., Albany, N. Y.
Warren Co., Inc., Chicago.
BELTING.
Chicago Rawhide Mfg. Co., Chicago, Ill.
Shultz Belting Co., St. Louis, Mo.
BLOWERS.
Fuller Co., Detroit.
Sturtevant Co., Boston, Mass.
BOILER COMPOUNDS.
Dearborn Drug & Chem. Wks., Chicago.
Lord, Geo. W., Philadelphia, Pa.
BOILER INSPECTION AND INSURANCE.
Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.
BOILERS.
Babcock & Wilcox Co., New York.
Hazelton Boiler Co., Rutherford, N. J.
Heine Safety Boiler Co., St. Louis.
Leffel & Co., Jas., Springfield, O.
Murray Iron Works Co., Burlington, Ia.
Smith, S. Morgan, Co., York, Pa.
Stirling Co., New York and Chicago.
BOILER TUBE AND FLUE CLEANERS.
Lagonda Mfg. Co., Springfield, O.
BOOKS.
Audel & Co., New York.
Spon & Chamberlain, New York.
Tulley, H. C., Co., St. Louis.
Van Nostrand Co., New York.
Zeller & Co., Geo. A., St. Louis.
BORING TOOLS.
G. & E. Elec. Co., Binghamton, N. Y.
McCrea & Co., Jas., Chicago.
BOXES, JUNCTION, OUTLET, TERMINAL.
Bossert Electric Con. Co., Utica, N. Y.
D. & W. Fuse Co., Providence, R. I.
BRUSHES. DYNAMO AND MOTOR.
American Electl. & Maintenance Co., N.Y.
Dixon Crucible Co., Jos., Jersey City, N.J.
K. & W. Company, Pittsfield, Mass.
Le Valley Vitae Carbon Brush Co., N. Y.
U. S. Elec, Contrg. Co., Syracuse, N. Y.
Wirt Elec. Co., The, Philadelphia.
BURNERS, GAS, ELECTRIC.
Electric Gas Lighting Co., Boston, Mass.
CARBONS, ELECTRIC LIGHT.
Reisinger, Hugo, New York.
CASTINGS, IRON.
Smith, S. Morgan, Co., York, Pa.
CEMENT FOR BELTS.
Warren Co., Inc., Chicago.
CHAINS.
Jeffrey Mfg. Co., Columbus, O.
CIRCUIT BREAKERS.
Cutter Co., Philadelphia, Pa.
Ward Leonard Elec. Co., Bronxville, N.Y.
CLAMPS FOR STEAM JOINTS.
McCrea & Co., Jas., Chicago.
CLIMBERS.
Klein, M., & Son, Chicago, Ill.
Reidy, J. J., New Haven, Conn.
Smith & Hemenway, N. Y.
CLOTHING FOR WORKMEN.
Carhartt, Hamilton, Detroit, Mich.
Cleveland & Whitehill, Newburgh, N. Y.
COAL AND ASHES HANDLING MACHY.
Jeffrey Mfg. Co., Columbus, O.
COAL MINING MACHINERY.
Jeffrey Mfg. Co., Columbus, O.
COLORING COMPOUNDS, LAMP.
Signaloid Chemical Works, Jersey City, N. J.
COMMUTATORS & BARS.
Homer Commutator Co., Cleveland.
COMMUTATOR COMPOUNDS.
K. & W. Co., Pittsfield, Mass.
Le Valley Vitae Carbon Brush Co., N. Y.
McLennan, K., & Co., Chicago, Ill.
Southworth & Hare, Indianapolis, Ind.
CONDENSERS.
Conover Mfg. Co., New York.
Stilwell-Bierce & S.-V. Co., Dayton, O.
CONDUITS.
Sprague Electric Co. (Interior), N. Y.
CONNECTORS.
Smith & Hemenway, N. Y.
CONVEYORS, COAL AND ASHES.
Jeffrey Mfg. Co., Columbus, O.
COOLING TOWERS.
Stocker, Geo. J., St. Louis.
CORRESPONDENCE SCHOOLS.
American School of Corres., Boston.
Consolidated Schools, New York.
Electrical Engineer Institute of Correspondence Instruction, New York.
International Corres. Sch'ls, Scranton, Pa.
CROSS ARMS, BRACKETS AND PINS.
Anderson & Sons, Detroit.
Central Mfg. Co., Chattanooga, Tenn.
Electric Appliance Co., Chicago, Ill.
Western Elec. Co., Chicago.

QUEEN PORTABLE PHOTOMETER.



WE ARE PREPARED TO MAKE ACCURATE TESTS OF SAMPLE LAMPS.

Switchboard and Portable **Meters.** PHOTOMETRIC APPARATUS. INDUCTION COILS. SCIENTIFIC INSTRUMENTS. Portable and Cable **Testing Sets.**

QUEEN & CO., Inc.,
480 Monon Bldg., Chicago. J. G. GRAY, President. 59 Fifth Ave., New York.
Philadelphia, Pa.

Classified List of Advertisers Continued.

CUT-OUTS.
- D. & W. Fuse Co., Providence, R. I.
- Fagan, J. C., Watertown, N. Y.
- Marshall-Sanders Co., Boston.

DESK LAMPS.
- McLeod, Ward & Co., N. Y.

DRILLS.
- Morse T. D. & M. Co., New Bedford, Mass.

ELECTRICAL HOUSE GOODS.
- Central Electric Co., Chicago.
- Electric Appliance Co., Chicago, Ill.
- Electric Gas Lighting Co., Boston.
- Partrick, Carter & Wilkins, Phila.
- Western Elec. Co., Chicago.
- Western Elecl. Supply Co., St. Louis.

ELECTRICAL MACHINISTS.
- Homer Commutator Co., Cleveland.

ELECTRO-MEDICAL APPARATUS.
- Partrick, Carter & Wilkins, Phila.
- Pignolet, L. M., New York.

ELEVATORS.
- Jeffrey Mfg. Co., Columbus, O.

ENGINEERS AND CONTRACTORS.
- Arnold Elec. Power Station Co., Chicago.
- General Elec. Co., Schenectady, N. Y.
- Humphrey, H. H., St. Louis, Mo.
- Jeffrey Mfg. Co., Columbus, O.
- Machado & Roller, New York.
- Thayer, R. L., Peoria, Ill.
- Western Elec. Co., Chicago.
- Westinghouse, Church, Kerr & Co., N. Y.
- Westinghouse Electric & Mfg. Co.

ENGINES, GAS AND GASOLINE.
- Columbus Machine Co., Columbus, O.
- Mietz, A., New York.
- Stand. Auto. Gas Eng. Co., Oil City, Pa.

ENGINES, STEAM.
- Amer. Engine Co., Bound Brook, N. J.
- Ball Engine Co., Erie, Pa.
- Ball & Wood, New York.
- Cooper, The C. & G., Co., Mt. Vernon, O.
- Filer & Stowell, Milwaukee, Wis.
- Fuller Co., Detroit, Mich.
- Harrisburg Fdy. & M. Co., Harrisburg, Pa.
- Leffel & Co., Jas., Springfield, O.
- McIntosh & Seymour Co., Auburn, N. Y.
- Murray Iron Works Co., Burlington, Ia.
- New Britain M. Wks., New Britain, Conn.
- Pierce Engineering Co., New York.
- Providence Eng. Wks., Providence, R. I.
- Quincy Engine Works, Quincy, Ill.
- Racine Hardware Co., Racine, Wis.
- Skinner Engine Co., Erie, Pa.
- Southwark Fndry. & Mach. Co., Phila.
- St. Louis Iron & Mch. Wks., St. Louis, Mo.
- Sturtevant, B. F., Co., Boston, Mass.
- Vilter Mfg. Co., Milwaukee, Wis.
- Westinghouse, Church, Kerr & Co., N. Y.
- Westinghouse Mach. Co., Pittsburg, Pa.

EXHAUST HEADS.
- Burt Mfg. Co., Akron, O.
- Sims Co., Erie, Pa.
- Sturtevant Co., Boston, Mass.

EXHAUST STEAM HEATING.
- Amer. Dist. Steam Co., Lockport, N. Y.

FANS.
- Central Electric Co., Chicago.
- Electric Appliance Co., Chicago, Ill.
- Emerson Electric Mfg. Co., St. Louis, Mo.
- Fuller Co., Detroit, Mich.
- General Elec. Co., Schenectady, N. Y.
- Robbins & Meyers Co., Springfield, O.
- Sprague Elec. Co., New York.
- Sturtevant, B. F., Boston, Mass.
- Warren Elec. & Spec. Co., Warren, O.
- Western Electric Co., Chicago.
- West Elec. Supply Co., St. Louis, Mo.
- Westinghouse Elec. & Mfg. Co., Pittsburg.

FILES.
- Barnett, G. & H., Co., Philadelphia, Pa.

FILTERS, OIL.
- Burt Mfg. Co., Akron, O.
- Phoenix Auto. Filter Co., Racine, Wis.
- Pittsburgh Gage & Supply Co., Pittsburgh.
- Robertson, James L., & Son, New York.
- Sims Co., Erie, Pa.

FIRE POTS.
- Clayton-Lambert Mfg. Co., Detroit, Mich.

FIXTURES, ELEC. AND COMBINATION.
- Electric Appliance Co., Chicago, Ill.
- Faries Mfg. Co., Decatur, Ill.
- Horn & Brannen Mfg. Co., Phila.
- White Co., O. C., Worcester, Mass.

FLASH LIGHTS, ELECTRIC.
- Roche, Wm., New York.

FUSES.
- American Elec. Fuse Co., Chicago.
- Chase-Shawmut Co., Boston.
- D. & W. Fuse Co., Providence, R. I.
- Johns, H. W., Mfg. Co., New York.

GASKETS.
- U. S. Mineral Wool Co., New York.

GEARS AND PINIONS.
- Chicago Rawhide Co., Chicago.
- New Process Rawhide Co., Syracuse.

GRAPHITE.
- Dixon Crucible Co., Jersey City, N. J.

GRATES, SHAKING.
- Robertson, James L., & Son, New York.

HEATERS, PURIFIERS, FEED-WATER.
- Harrison Safety Boiler Works, Phila.
- Hoppes Mfg. Co., Springfield, O.
- Pittsburgh Gage & Supply Co., Pittsburgh.
- Robertson, James L., & Son, New York.
- Stewart Heater Co., Buffalo, N. Y.
- Stilwell-Bierce & S.-V. Co., Dayton, O.

HEATING & VENTILATING APPARATUS.
- Sturtevant Co., Boston, Mass.

HEATING APPARATUS, ELECTRICAL.
- American Elec. Heater Co., Detroit.
- Simplex Elec. Co., Cambridgeport, Mass.

INDICATORS.
- Robertson, Jas. L., & Son, New York.

INSTRUMENTS, ELECTRICAL.
- Akron Elec. Mfg. Co., Akron, O.
- Belknap Motor Co., Portland, Me.
- Biddle, J. G., Philadelphia. Pa.
- Bristol Co., Waterbury, Conn.
- Diamond Meter Co., Peoria, Ill.
- Eldredge Elec. Mfg. Co., Springfield, Mass.
- Electric Appliance Co., Chicago, Ill.
- Elec. Motor & Equip. Co., Newark, N. J.
- General Elec. Co., Schenectady, N. Y.
- Halsey, E. S., Chicago.
- Keystone Elec. Instr. Co., Phila.
- Knott Apparatus Co., L. E., Boston.
- Machado & Roller, New York.
- Norton Elec. Instr. Co., Manchester, Conn.
- Pignolet, Louis, New York.
- Portland Co., Portland, Me.
- Queen & Co., Philadelphia, Pa.
- Sage & Bro., New York.
- Stanley Instr. Co., Gt. Barrington, Mass.
- Western Elecl. Supply Co., St. Louis. Mo.
- Weston Elec. Instr. Co., Waverly Park.
- Whitney Elec. Instr. Co., Penacook, N. H.
- Willyoung, E. G., New York.
- Wirt & Co., Charles, Philadelphia.

INSULATORS AND IN. MATERIALS.
- Bossert Elec. Cons. Co., Utica, N. Y.
- Elec. Appliance Co., Chicago, Ill.
- Hudson Porcelain Works, N. Y.
- Mica Insulator Co., New York.
- Munsell & Co., New York.
- Okonite Co., New York.
- Protectorate Co., Chicago.
- Standard Paint Co., New York.
- Sterling Varnish Co., Pittsburgh, Pa.
- Steward, D. M., Co., Chattanooga, Tenn.
- Western. Elecl. Supply Co., St. Louis, Mo.

IRON WORK.
- Anderson & Sons, Detroit, Mich.

LAMPS, ARC.
- American Elecl. & Maintenance Co., N. Y.
- Anderson Tool Co., Anderson, Ind.
- Baker & Fox (Theater), Brooklyn, N. Y.
- General Elec. Co., Schenectady, N. Y.
- Hamblin, J. A., Providence, R. I.
- Manhattan Gen'l Cons. Co., Newark, N. J.
- Toerring, C. J.. Co., Phila.
- Western Elec. Co., Chicago, Ill.
- West. Elec. Supply Co., St. Louis.
- Westinghouse Elec. & Mfg. Co.

LAMPS, INCANDESCENT.
- American Elecl. & Maintenance Co., N. Y.
- Am. Min. and Dec. Lamp Co., New York.
- Banner Electric Co., Youngstown, O.
- Central Electric Co., Chicago.
- Colonial Elec. Co., Ravenna, O.
- Colorado Lamp Co., Denver, Col.
- Economy Elec. Co., Warren, O.
- Elec. Appliance Co., Chicago, Ill.
- General Elec. Co., Schenectady, N. Y.
- Hewitt & Warden, Newburgh, N. Y.
- Kentucky Electrical Co., Owensboro, Ky.
- McLeod, Ward & Co., N. Y.
- New York & Ohio Co., Warren, O.
- Penn. Elec. & Ry. Supply Co., Pittsburgh.
- Phelps Co., Detroit, Mich.
- Pittsburgh Elec. Lamp Co., Braddock, Pa.
- Sawyer-Man Elec. Co., Pittsburgh.
- Shelby Electric Co., Shelby, O.
- Sterling Electl. Mfg. Co., Warren, O.
- Warren Elec. & Specialty Co., Warren, O.
- Western Elec. Co., Chicago.
- West Elec. Supply Co., St. Louis, Mo.

LATHES.
- Seneca Falls Mfg. Co., Seneca Falls, N. Y.

LIGHTNING ARRESTERS.
- Central Electric Co., Chicago.
- Garton-Daniels Co., Keokuk, Ia.
- General Elec. Co., N. Y.
- Westinghouse Elec. & Mfg. Co.

LUBRICATORS.
- Stephenson Mfg. Co., Albany, N. Y.

MAGNETS.
- North Electric Co., Cleveland, O.
- Varley Duplex Mag. Co., Phillipsdale, R. I

MECHANICAL DRAFT.
- Sturtevant Co., Boston, Mass.
- Westinghouse, Church, Kerr & Co., N. Y.

METAL POLISH.
- Hoffman, G. W., Indianapolis, Ind.

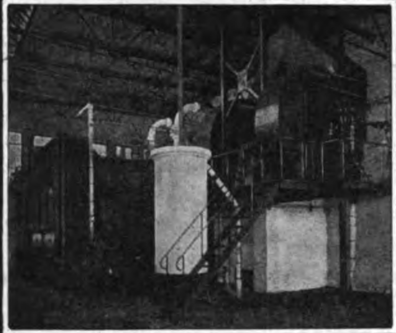
METERS.
- Diamond Meter Co., Peoria, Ill.
- Halsey, E. S., Chicago.
- Stanley Instr. Co., Gt. Barrington, Mass.

MICA.
- Munsell & Co., Eugene, New York.

MODELS.
- Baillard, E. V., New York.
- Parsell & Weed, New York.

MOTORS AND DYNAMOS.
- Akron Elec. Mfg. Co., Akron, O.
- American Electl. & Maintenance Co., N. Y.
- Bartz, Evans & Wygant, H'n'sville, N. Y.
- Bernard, E. G., Troy, N. Y.
- Bullock Co., Cincinnati, O.
- C & C Electric Co., New York.
- Central Electric Co., Chicago.
- Commercial Elec. Co., Indianapolis, Ind.
- Crocker-Wheeler Co., Ampere, N. J.
- Eddy Elec. Mfg. Co., Windsor, Conn.
- Emerson Elec. Mfg. Co., St. Louis, Mo.
- Engberg's E. & M. Wks., St. Joseph, Mich.
- Fuller Co., Detroit, Mich.
- General Elec. Co., Schenectady, N. Y.
- Hobart Electric Mfg. Co., Troy, Ohio.
- Holtzer-Cabot Elec. Co., Boston.
- Jenney Elec. Mfg. Co., Indianapolis, Ind.
- Kentucky Elec. Co., Owensboro, Ky.
- N. E. Motor Co., Lowell, Mass.
- Parsell & Weed, New York.
- Reliance Electric Co., Milwaukee.
- Robbins & Myers Co., Springfield, O.
- Roth Bros. & Co., Chicago, Ill.
- Sprague Elec. Co., New York.
- Sturtevant, B. F., Co., Boston, Mass.
- Triumph Elec. Co., Cincinnati, O.
- Thresher Elec. Co., Dayton, O.
- Warren Elec. Mfg. Co., Sandusky, O.
- Western Elec. Co., Chicago.
- West Elec. Supply Co., St. Louis.
- Westinghouse Elec. & Mfg. Co., Pittsburgh.

OILS AND LUBRICANTS.
- Dixon Crucible Co., Jersey City, N.



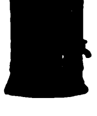
STURTEVANT SYSTEM
OF
MECHANICAL DRAFT

Saves cost of Chimney.
Burns cheap fuel.
Increases boiler capacity.
Responds instantly to sudden demands for steam.

Send for Catalogue No. 110.

B. F. STURTEVANT COMPANY, BOSTON
NEW YORK PHILADELPHIA CHICAGO LONDON

36



THE TRACY OIL FILTER
Made in All Sizes.
SEND FOR CIRCULAR.

Write to Our Nearest Agency:
Manning, Maxwell & Moore, New York, Chicago, San Francisco.
The Fairbanks Co., any large city.
Brown Bros. Co., Providence, R. I.
N. O. Nelson Mfg. Co., St. Louis, Mo.
Hendrie & Bolthoff Mfg. Co., Denver, Colo.
Darling Bros., Montreal, Quebec.
National Oil Works & Mill Supply Co., New Orleans, La.
Fred. W. Wolf Co., Chicago, Ill.

PHOENIX AUTOMATIC FILTER CO.,
RACINE, WIS., U. S. A.

LAVA HAS THE HIGHEST HEAT RESISTANCE
TRADE MARK

We make it into insulators for all kinds of Electric Work. It is better than rubber or fibre and

CHEAPER THAN MICA.

Lava takes a clean, sharp, accurate thread that is good to look at. Samples made from model, blueprint or mechanical sketch. Send yours.

D. M. STEWARD MFG. CO., CHATTANOOGA, TENN. NEW YORK, 107 Chambers St

LE VALLEY VITAE CARBON BRUSH CO.,
45 Broadway,
NEW YORK CITY.

COMMUTATORS LAST
5 Times Longer
With Le Valley Brushes.
Le Valley Brushes Last
4 Times Longer
Than other Carbon Brushes.
CALCULATE YOUR SAVING.

Classified List of Advertisers Continued.

OIL EXTRACTORS.
Baum Separator Co., Reading, Pa.
PACKING.
Penn. Elec. & Ry. Supply Co., Pittsburgh.
Quaker City Rubber Co., Philadelphia.
PLANIMETERS.
Robertson, Jas., L. & Son, New York.
PLATINUM.
Baker & Co., Newark, N. J.
PLYERS AND NIPPERS.
Smith & Hemenway, N. Y.
POLE STEPS.
Anderson & Sons, Detroit.
PORCELAIN GOODS.
Hudson Porcelain Works, N. Y.
POWER TRANSMISSION.
Jeffrey Mfg. Co., Columbus, O.
Smith, S. Morgan, Co., York, Pa.
PULLEYS.
Rockford Mfg. Co., Indianapolis, Ind.
Smith, S. Morgan Co., York, Pa.
PULLEY COVER, LIQUID.
Warren Co., Inc., Chicago.
PUMPS.
Conover Mfg. Co., New York.
Stewart Heater Co., Buffalo, N. Y.
RAIL BONDS.
American Steel & Wire Co., Chicago.
RAILWAY SUPPLIES, ELECTRIC.
Central Electric Co., Chicago.
General Electric Co.
REFLECTORS AND SHADES.
Am. Reflector & Lighting Co., Chicago.
Elec. Appliance Co., Chicago, Ill.
Frink, I. P., New York.
Holophane Glass Co., New York.
Murray, J. J., & Co., Philadelphia.
Phoenix Glass Co., New York.
REGULATORS, DAMPER, PRESSURE.
Mason Regulator Co., Boston, Mass.
REPAIRING, ELECTRICAL.
American Electl. & Maintenance Co., N.Y.
Bruce-Hibbard Elec. Co., Fitchburg, Mass.
Heck, Louis, Newark, N. J.
Homer Commutator Co., Cleveland, O.
Parsell & Weed, New York.
Penn. Elec. & Ry. Supply Co., Pittsburg.
Stewart Elec. Co., Cincinnati, O.
Stucky, Jacob, Newark, N. J.
Van Dorn-Elliott Elec. Co., Cleveland.
RHEOSTATS.
Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Cutter Co., Philadelphia, Pa.
Ward Leonard Elec. Co., Bronxville, N. Y.
Wirt Elec. Co., The, Philadelphia.
SAFETY WATER COLUMNS.
Wright Mfg. Co., Detroit.
SCALES.
Clarke Automatic Scales Co., New York.
SCHOOLS AND COLLEGES.
Mich. College of Mines, Houghton, Mich.
SCRAPING TOOLS.
Mound Tool & Scraper Co., St. Louis.
SECOND-HAND APPARATUS.
Bernard Co., E. G., Troy, N. Y.
General Elec. Co., Schenectady, N. Y.
Rossiter, MacGovern & Co., New York.
Stewart Elec. Co., Cincinnati, O.
SEPARATORS- STEAM AND OIL.
Austin Separator Co., Detroit, Mich.
Baum Separator Co., Reading, Pa.
Beggs, James, & Co., New York.
Harrison Safety Boiler Wks., Phila., Pa.
Hoppes Mfg. Co., Springfield, O.
Stewart Heater Co., Buffalo, N. Y.
Westinghouse, Church, Kerr & Co., N. Y.
SIGNS, ELECTRIC.
Elec. Motor & Equip. Co., Newark, N. J.
SLATE, ELECTRICAL.
McNamara Bros., Fair Haven, Vt.
SOCKETS.
Marshall-Sanders Co., Boston.
N. E. Elec. Mfg. Co., Boston.
SOLDER.
Anchor Chemical Co., Brooklyn, N. Y.
Cream Flux Co., Chicago.
SPRINGS.
American Steel & Wire Co., Chicago.
Barnes, Wallace, Bristol, Conn.
Cary Spring Works, New York.
Manross, F. N., Forestville, Conn.
STACKS.
Hazelton Boiler Co., Rutherford, N. J.
STEAM PIPE AND BOILER COVERING.
Keasbey, R. A., New York.
STEAM TRAPS.
Albany Steam Trap Co., Albany, N. Y.
STOKERS.
Westinghouse, Church, Kerr & Co., N. Y.
SUPPLIES, ELECTRICAL.
Alden Electric Co., Chicago.
American Electl. & Maintenance Co., N. Y.
Central Electric Co., Chicago.
Chase-Shawmut Co., Boston.
Electric Appliance Co., Chicago, Ill.
Elec. Gas Lighting Co., Boston, Mass.
General Elec. Co., Schenectady, N. Y.
Marshall-Sanders Co., Boston.

(Classified Index continued on page 16.)

GRAPHITE BRUSHES.
They have been fully tested and proved superior to any in the market.
We shall be pleased to send sample.
JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J.

HIGHEST GRADE NUERNBERG CARBONS
FOR ENCLOSED LONG BURNING ARC LAMPS,
FOR DIRECT CURRENT,
FOR ALTERNATING CURRENT
ARC LAMPS.

ELECTRA CARBONS

ELECTRA
TRADE MARK

UNEQUALED IN
QUALITY AND EFFICIENCY.
PRODUCE EXCELLENT, UNIFORM,
STEADY AND BRILLIANT LIGHT.

HUGO REISINGER 11 BROADWAY, NEW YORK.

Notice. See that every package of my Carbons bears the label with my trade-mark, "Electra," thus. Beware of imitations. To protect the interests of purchasers of my Carbons I am determined to proceed against infringers of my "Electra" trade-mark.

Publications of AMERICAN ELECTRICIAN,
120 Liberty Street, New York, U. S. A.

Algebra Made Easy—Houston & Kennelly. 101 pages, with diagrams	$0.75
Dynamo and Motor Building for Amateurs—Parkhurst. 163 pages, 73 illustrations	1.00
Electricity Made Easy—Houston & Kennelly. 348 pages, 207 illustrations	1.50
Electric Railway Motors—Perry. 175 pages, 140 illustrations	1.00
Electrical Engineering Leaflets—Houston & Kennelly.	
ELEMENTARY GRADE—296 pages, 121 illustrations	1.50
INTERMEDIATE GRADE—300 pages, 140 illustrations	1.50
ADVANCED GRADE—296 pages, 121 illustrations	1.50
Interpretation of Mathematical Formulae—Houston & Kennelly. 225 pages, 9 diagrams	1.25

Copies of any of the above books or of any other electrical book published will be sent by mail, POSTAGE PREPAID, to any address in the world on receipt of price.

EVERY SUPPLY HOUSE
should carry a line of our

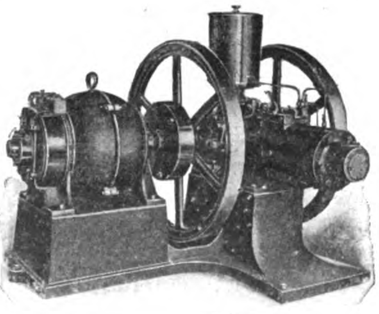
New "Type S" Switch

The only first-class switch on the market to-day that can be sold at a moderate price.

We ship ON APPROVAL, and guarantee satisfaction in every respect.

BARKELEW ELECT. MFG. CO.,
MIDDLETOWN, OHIO.

EVERY issue of the AMERICAN ELECTRICIAN is filled with important and timely articles reflecting the latest advances in both electrical and steam engineering and practice, the aim being always to present matter of ***real*** intrinsic value to everyone interested in electricity and its applications. : : : : : : : : :



GOLD MEDAL.

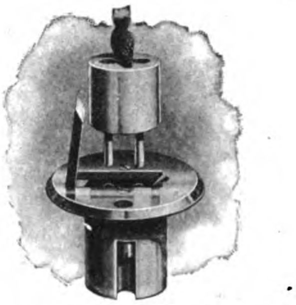
Highest Award for Kerosene Engines at the Pan-American

THE MEITZ & WEISS
GAS AND KEROSENE ENGINE.

Burns KEROSENE cheaper and safer than gasoline. Automatic, simple and reliable. No electric battery or flame used. Perfect regulation. Belted or directly coupled to dynamos for electric lighting, charging storage batteries and all other power purposes.

SEND FOR CATALOGUE. A. MIETZ, 128-130 Mott Street, New York City.

"A hit, a very palpable hit."—Shakespeare.



Marshall-Sanders Midget Plug and Receptacle

No. 521. List $1.00

One-half the price of any similar device—simpler and better adapted to requirements.

***We also make Flush and Push* Switches; *Edison, T. H., and Westinghouse* Sockets; N. M. Rosettes; S. M. Branches and Mains; Edison Plug Cut-outs.**

Our Catalogue describes 608 things electrical that are "worth while."

MARSHALL-SANDERS CO., - - 303 Congress Street, Boston, Mass.

WATER WHEELS

FOR HEADS OF 3 FEET TO 2000 FEET.

Adapted to All Kinds of

WATER POWER PLANTS.

We Guarantee HIGHEST POWER, SPEED and EFFICIENCY

from part to full gate ever obtained from a wheel of same dimensions. Pamphlet sent on request. Please advise power required and your head of water.

JAMES LEFFEL & CO., Springfield, Ohio, U. S. A.

THE HORN & BRANNEN MFG. CO.

FACTORY AND SALESROOMS,
427-429-431-433 NORTH BROAD ST.,
PHILADELPHIA.

DESIGNERS AND MANUFACTURERS OF

Gas and Electric Light Fixtures

CORRESPONDENCE SOLICITED

American Electrical Heater Co.,

MANUFACTURERS OF ELECTRIC

Soldering Irons, Tailor's Irons, Laundry Irons, Hat Irons, Curling Iron Heaters, Glue Pots, Air Heaters, Etc.

Also other devices for Electrical Heating.

197 River St., Detroit, Mich.

HENRY H. HUMPHREY,
Consulting Electrical Engineer.

Central Lighting Stations,
Electric Power Transmission.

Suite 1305 Chemical Building,
ST LOUIS.

WHEN writing to Advertisers please mention the AMERICAN ELECTRICIAN.

Classified List of Advertisers Continued.

Manhattan Elec. Supply Co., N. Y.
N. E. Elec. Mfg. Co., Boston.
Newman-Spranley Co., Ltd., N. Orleans.
Partrick, Carter & Wilkins, Phila.
Roberts, H. C., Elec. Supply Co., Phila.
Western Electric Co., Chicago.
Western Elec. Supply Co., St. Louis, Mo.
Westinghouse Elec. & Mfg. Co.

SWITCHES AND SWITCHBOARDS.
Barkelew Elec. Mfg. Co., Middletown, O.
Bossert Elec. Cons. Co., Utica, N. Y.
Chase-Shawmut Co., Boston.
Crouse-Hinds Elec. Co., Syracuse, N. Y.
Cutter Co., Philadelphia.
Electric Appliance Co., Chicago, Ill.
General Inc. Arc Light Co., N. Y.
General Elec. Co., Schenectady, N. Y.
Hart & Hegeman, Hartford, Conn.
Hart Mfg. Co., Hartford, Conn.
Hewitt & Warden, Newburgh, N. Y.
Hill, W. S., Elec. Co., New Bedford, Mass.
Linton, G. E., & Co., Worcester, Mass.
Machado & Roller, New York.
Marshall-Sanders Co., Boston.
McNamara Bros. (Slate), Fair Haven, Vt.
O. K. Specialty Mfg. Co. (Time), Garrettsville, O.
Ward Leonard Elec. Co., Bronxville, N. Y.
White, H. P., & Co., Philadelphia, Pa.
Simdars and Hunt, New York.

TANKS.
Hazelton Boiler Co., Rutherford, N. J.

TELEGRAPH APPARATUS.
Dunn-Martin Elec. Co., New York City.
Electric Appliance Co., Chicago, Ill.
Manhattan Elec. Supply Co., N. Y.

TELEPHONES.
Century Tel. Cons. Co., Cleveland.
Electric Appliance Co., Chicago, Ill.
Ericsson Tel. Co., New York.
Farr Telephone C. & S. Co., Chicago.
Garl Elec. Co., Akron, O.
Kellogg Switchb'd & Sy. Co., Cnicago, Ill.
Manhattan Elec. Supply Co., N. Y.
New York Tel. Co., New York.
North Electric Co., Cleveland.
Schmidt Tel. Mfg. Co., Lambert, N. Y.
Stromberg-Carlson Tel. Mfg. Co., Chicago.
Telephone Co. of America, Wash., D. C.
Western Electl. Supply Co., St. Louis, Mo.

THEATER DIMMERS.
Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Ward Leonard Elec. Co., Bronxville, N. Y.

TIME SWITCHES.
O. K. Specialty Mfg. Co., Garrettsville, O.

TOOLS.
Anderson, W. H., & Sons, Detroit, Mich.
Central Electric Co., Chicago.
Smith & Hemenway, New York.

TORCHES.
Clayton & Lambert Mfg. Co., Detroit.

TRANSFORMERS.
Central Electric Co., Chicago.
Electric Appliance Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Kuhlman Electric Co., Elkhart, Ind.
Moloney Elec. Co., St. Louis.
New York & Ohio Co., Warren, O.
Penn. Elec. & Ry. Supply Co., Pittsburgh.
Pittsburgh Transformer Co., Pittsburgh.
Vindex Electric Co., Chicago.
Wagner Elec. Mfg. Co., St. Louis.
Warren Elec. & Spec. Co., Warren, O.
Westinghouse Elec. & Mfg. Co.

TUBING, FLEXIBLE.
Smith & Co., A. L., Phila.

TURBINE WATER WHEELS.
Christiana Machine Co., Christiana, Pa.
Dayton Globe Iron Wks. Co., Dayton, O.
Leffel, James & Co., Springfield, O.
Pelton Water Wheel Co., San Fran., Cal.
Smith, S. Morgan, Co., York, Pa.
Stilwell-Bierce & S.-V. Co., Dayton, O.

VALVES.
Croslen Mfg. Co., Chicago, Ill.
Darling Pump & Mfg. Co., W'msport, Pa
Mason Regulator Co., Boston, Mass.
Ludlow Valve Mfg. Co., Troy, N. Y.

VARNISHES.
Sterling Varnish Co., Pittsburgh, Pa.

VOLTAGE REGULATORS.
Belknap Motor Co., Portland, Maine.
Portland Co., Portland, Me.

WATER-WHEEL GOVERNORS
Lombard Governor Co., Boston.
Replogle Governor Works, Akron, O.

WIRES AND CABLES.
Amer. Electric Works, Providence, R. I.
Amer. Steel & Wire Co., Chicago.
Central Electric Co., Chicago.
Collyer Ins. Wire Co., Pawtucket, R. I.
Electric Appliance Co., Chicago, Ill.
Kellogg Switchboard & Sup. Co., Chicago.
Okonite Co., Ltd., New York.
Phillips, Eugene F., Providence, R. I.
Phillips Ins. Wire Co., Pawtucket, R. I.
Roebling's, John A., Sons, Trenton, N. J
Stand. Underground Cable Co., Pittsburgn
Western Elec. Co., Chicago.
West Elec. Supply Co., St. Louis, Mo

WIRE GAUGES.
American Steel & Wire Co., Chicago.

X-RAY APPARATUS.
Knott, L. E., Apparatus Co., Boston.

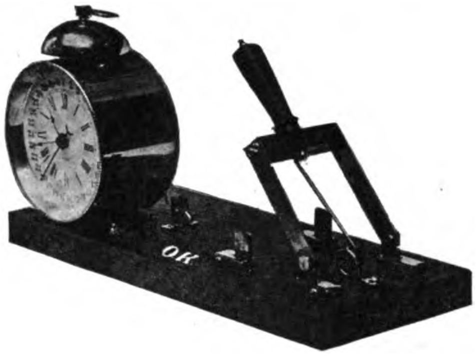
FACTORIES.
Perth Amboy, N. J.
Pittsburgh, Pa.
and
Oakland, Cal.

Standard Underground Cable Co.

Cables and Wires for all Underground, Submarine and Overhead Service Furnished and Installed.

Rubber, Paper, Fiber, Street Railway, Telegraph, Telephone and Electric Light Wires and Cables.

OFFICES.
Pittsburgh, Pa., Westinghouse Bldg.
N. Y. City, 36 Liberty St.
Philadelphia, Pa., 1725 Betz Bldg.
Chicago, Ill., 542 The Rookery.
San Francisco, Ca., Mills Bldg.
Boston, Mass., Tremont Bldg.



O. K. TIME Switches

Our prices talk.
Will you listen?

25 Ampere, 220 Volt, D. P., - - $3.00
50 Ampere, 220 olt, D. P., - - 4.00
75 Ampere, 220 Volt, D. P., - - 4.75
Write us for particulars.

O. K. SPECIALTY MFG. CO., Garrettsville, Ohio.

Back Numbers Wanted.

We desire to obtain the following back numbers of the American Electrician. In exchange for each copy of these, *in good condition*, we will extend your subscription two months:

January, 1901.
February, 1901.
March, - 1901.
April, - 1901.
May, - 1901.

Be sure to put your name on the package containing the papers and prepay the postage at the rate of one cent for each four ounces.

AMERICAN ELECTRICIAN CO.,
120 Liberty Street, New York, N. Y.

"ADVANCE" AUTOMATIC BURNER.

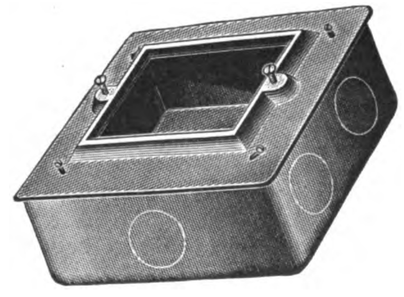
Cut Full Size.

Small Size.
Minimum Battery Power.

ELECTRIC E GAS G BOSTON LIGHTING L MASS. COMPANY C

"NEW STANDARD" ELECTRIC FLASHLIGHT No. 1

A RELIABLE LIGHT AT ALL TIMES.
WILL POSITIVELY GIVE EQUAL TO
FIFTEEN HOURS ACTUAL SERVICE.
Send for Circular and Prices.
WILLIAM ROCHE, No. 42 Vesey St., New York City.



STEEL WALL BOXES
For Conduit Outlets
For Distributing and Cut-out Boards

The Erickson Outlet Insulator

New York—R. B. Corey, Havemeyer Bldg.
Boston—F. B. Smith, 170 Summer Street.
Philadelphia—L. Bancroft Mellor, 14 So. Fourth Street.
Baltimore—A. L. Bosley, 221 N. Calvert St.
Chicago—W. P. Crockett, 613 Manhattan Bldg.
San Francisco—John R. Cole, 33 Second St.

SOLE MFRS. AND PATENTEES,
The Bossert Electric Construction Co.
UTICA, N. Y., U. S. A.

NOW READY.

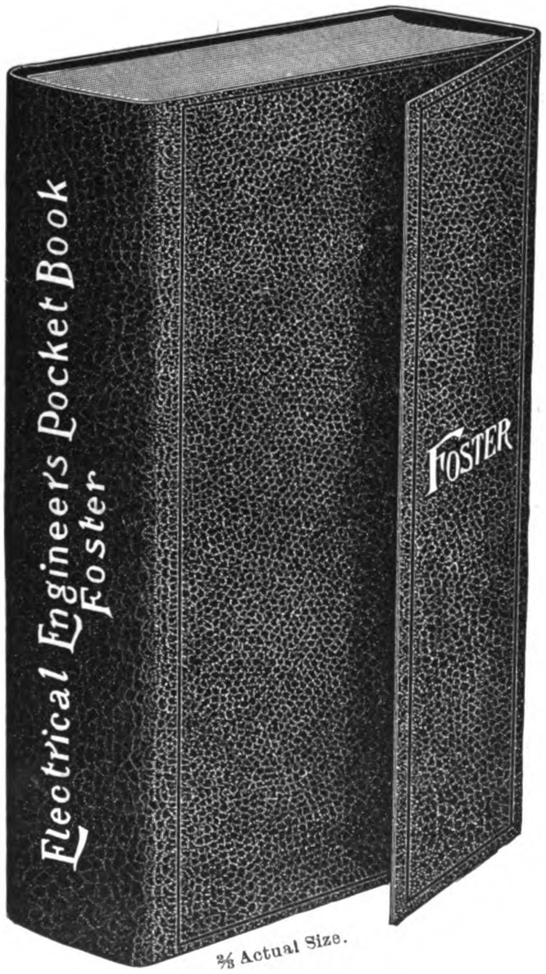
Pocket Size, Flexible Leather, 1000 pages, with innumerable Illustrations, Diagrams and Tables.

PRICE, $5.00.

Electrical Engineer's Pocket=Book

By **HORATIO A. FOSTER.**
MEMBER AMER. INST. E. E. MEMBER AM. SOC. M. E.
(With the collaboration of eminent specialists.)

The most complete book of its kind ever published, treating of the latest and best practice in Electrical Engineering.



⅝ Actual Size.

LIST OF CONTRIBUTORS.

SECTION.	REVISED BY
Electro-chemistry, Electro-metallurgy.	Prof. Francis B. Crocker.
Symbols, Units and Instruments.	Prof. Samuel Sheldon.
Transmission of Power.	Mr. T. C. Martin.
Switchboards and Switching Devices.	Mr. E. M. Hewlett.
Electric Lighting.	Mr. Townsend Wolcott.
Electricity in U. S. Navy.	Mr. J. J. Crain.
Resistance, Electrical Measurements.	Prof. Samuel Sheldon.
Certain Uses of Electricity in U. S. Army.	Mr. Grahame H. Powell.
Electric Street Railways.	Mr. John S. Griggs, Jr. J. G. White & Co.
Dynamos and Motors.	Mr. E. B. Raymond.
Storage Batteries.	Mr. Joseph Appleton. Mr. Townsend Wolcott.
Conductors (Properties of).	Prof. Samuel Sheldon.
Mechanical Section.	Mr. Wm. Wallace Christie. Mr. F. E. Idell.
Lightning Arresters.	Mr. Townsend Wolcott.
Lightning Conductors.	Prof. Alex. G. McAdie.
Cable Testing.	Mr. William Maver, Jr.
Electromagnets.	Mr. Townsend Wolcott.
Electric Heating, Cooking, and Electric Welding.	Mr. Max Osterberg. Mr. Max Loewenthal.
Dynamos and Motors Standard and Test.	Mr. E. B. Raymond.
Miscellaneous Section.	Mr. Townsend Wolcott.
Conductors (Relation and Dimension of).	Prof. Samuel Sheldon.
Telephony.	Mr. Herbert Laws Webb.
Telegraphy.	Mr. Chas. Thom.
Magnetic Properties of Iron.	Prof. Samuel Sheldon.
Determination of Wave Form.	Mr. Townsend Wolcott.
Static Transformers.	Mr. Walter S. Moody. Mr. Townsend Wolcott.
Electricity Meters.	Prof. Samuel Sheldon.
Underwriter's Code.	
Index Electrical Section.	Mr. Max. Loewenthal.
Index Mechanical Section.	Mr. Wm. Wallace Christie.

EXTRACT FROM PREFACE.

It is with some little trepidation that this book is put before the public, in view of the frequent important and even radical changes that up to the present have characterized the development of electrical engineering It has, however, been thought that the science has now reached a stage which renders necessary some manual that will be of assistance to the active worker in the various branches.

This book is not an encyclopedia, nor is it intended for a text-book, but it is hoped that as a compendium of useful data, it may assist the practising electrician and engineer.

The matter included is representative of American practice, and no effort has been made to include any other except in special cases.

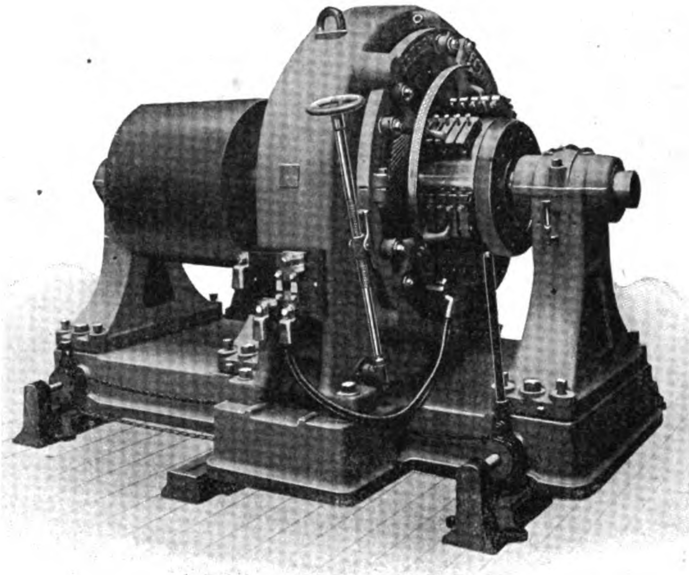
ADVANCE ORDERS FOR OVER 1000 COPIES.

D. VAN NOSTRAND CO., PUBLISHERS AND BOOKSELLERS,
23 Murray and 27 Warren Sts., New York.

Copies sent prepaid on receipt of price.

Western Electric Generators

Lighting and Power Purposes—Central Stations—Isolated Plants



Complete Installations

Arc Lighting Systems

WESTERN ELECTRIC COMPANY

CHICAGO ST. LOUIS PHILADELPHIA NEW YORK

AMERICAN ELECTRIC CO., St. Paul, Minn.
CALIFORNIA ELECTRICAL WORKS, San Francisco, Cal.
STANDARD ELECTRIC CO., Cincinnati, Ohio.
KILBOURNE & CLARK CO., Seattle, Wash.
ANTWERP. LONDON. PARIS.

Hewitt's Series Govorning Boards

Have stood the test for both efficiency and utility. These boards have a range from a single lamp to 40 per cent. above the normal. It has extreme flexibility and gives perfect control of Series Incandescent Circuits. HEWITT & WARDEN, 14 South Water St., Newburgh, N. Y. General Selling Agents for PEERLESS LAMPS AND TRANSFORMERS.

KELLOGG SWITCHBOARD AND SUPPLY CO.

237 SO. GREEN STREET, CHICAGO.

We are prepared to furnish best quality

Fine Magnet
Annunciator
Jumper
WIRE
Also
Switchboard
Cable

ANY SILK OR COTTON INSULATED WIRE MADE TO ORDER.
STANDARD PRODUCTS IN STOCK.

MODELS and Experimental Work.

Inventions Developed and all class of Special Work.

E. V. BAILLARD, FOX BLDG., FRANKLIN SQ., NEW YORK CITY.

GOULD

STORAGE BATTERIES

Have Received a Silver Medal Award at the Pan-American.

The reasons "why" are contained in our "Feature" pamphlet. WRITE FOR IT.

GOULD STORAGE BATTERY CO.,
25 West 33d Street, New York.

SUSPENSION, TYPE K TRANSFORMER.

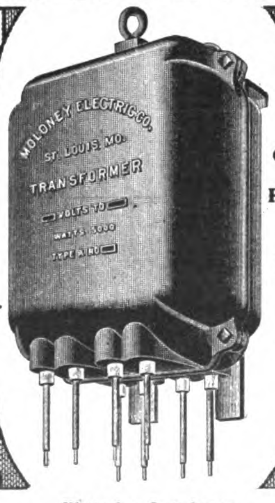
Write to our nearest Agency;
Manhattan Electrical Supply Co., New York.
E. G. Bernard Co., Troy, N. Y.
Rumsey Electrical Mfrs. Co., Philadelphia.
Central Electric Co., Chicago.
California Electrical Works, San Francisco.
Foreign Department:
No. 88 Maiden Lane, New York, N. Y.

THE ULTIMATE EFFICIENCY of a transformer depends very largely upon its durability. A transformer requiring frequent rewinding or other repairs is not truly efficient.

The substantial construction and careful workmanship of the TYPE K TRANSFORMER insure durability and immunity from burn-out.

Pittsburgh Transformer Company
Pittsburgh, Pa.

MOLONEY TRANSFORMER
GUARANTEED FOR TWO YEARS

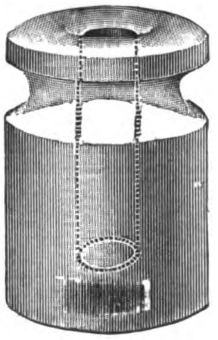

MOLONEY ELECTRIC CO.
ST. LOUIS, MO.
TRANSFORMER

NEW TYPE
HIGHEST EFFICIENCY.

CLOSEST REGULATION
PERFECT VENTILATION.

Write for Catalogue.
Moloney Electric Company,
423-425 N. Second St., St. Louis, Mo.
BRANCH OFFICES:
NEW YORK—H. B. Coho & Co., 149 Broadway.
PHILADELPHIA—Walker & Kepler, 531 Chestnut St.
ST. LOUIS, MO.—Western Electrical Supply Co., Agent.
PORTLAND, ORE., Northwest Electric Engineering Co., Agent.
ST. PETERSBURG, RUSSIA—American-Russian Import & Export Co., Agent.

PORCELAIN INSULATORS,



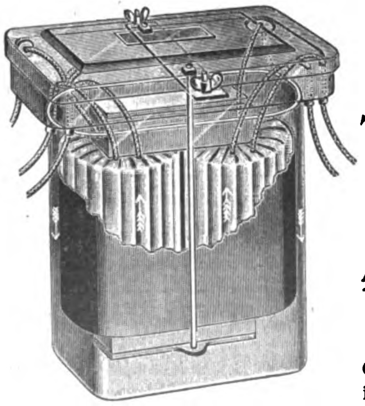
CLEATS, and special porcelain of all kinds for electrical purposes.

Quality High.
Prices Low.

CORRESPONDENCE INVITED.

HUDSON
Porcelain Works,

Sales Office, 203 BROADWAY, NEW YORK.



A NEW STEEL Transformer Case.

A Two-Years' Guarantee
against any and all loss.

Give us a Trial—If you like it tell others; if not, tell us.

KUHLMAN ELECTRIC COMPANY,
ELKHART, IND.

“PEERLESS”
TRANSFORMERS

Representing Years of Experienced Transformer Building, Worthily Uphold their Name—they ARE “Peerless.”

MANUFACTURED BY

THE WARREN ELECTRIC AND SPECIALTY CO.,
WARREN, OHIO, U. S. A.

WRITE OUR NEAREST AGENT.

Stanley & Patterson, 32 Frankfort St., New York, N. Y.
Vallee Bros., Electric Co., 625 Arch St., Philadelphia, Pa.
The Illinois Electric Co., 239-241 Madison St., Chicago, Ill.
The Standard Elec. Co., 201 W. Pearl St., Cor. Elm, Cincinnati.
The Electric Supply & Mfg. Co., 62 Public Square, Cleveland, O.
The Stuart-Howland Co., 283-285 Devonshire St., Boston, Mass.
Hewitt & Warden, Newburgh, N. Y.
St. Louis Electric Supply Co., 911 Market St., St. Louis, Mo.

“CROUSE HINDS”
NEW YORK CHICAGO
SYRACUSE
“QUALITY TALKS”

ASK ANYONE!

Does This Name
on SWITCHES
SWITCHBOARDS
and PANELBOARDS
Mean That They Are

O. K. ELECTRICALLY
MECHANICALLY
ARTISTICALLY ? ? ?

VINDEX Electric Co.
CHICAGO, ILL.

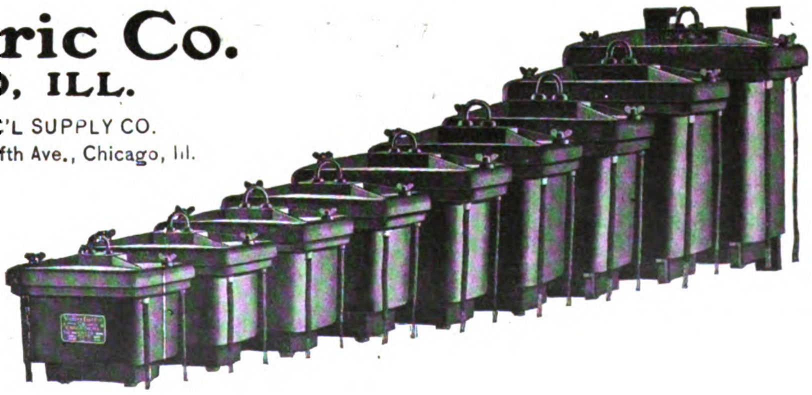
BROWN & McLAIN,
Boston, Mass.

MANHATTAN ELEC’L SUPPLY CO.
188 Fifth Ave., Chicago, Ill.

MISSOURI ELEC. MFG. CO.,
St. Louis, Mo.

VARNEY ELECTRICAL SUPPLY CO.,
Indianapolis, Ind.

MECHANICS’
SUPPLY CO.,
Quebec.



Transformers

Factory
Aurora, Illinois

Manufacturers of Electrical Supplies

...OF ALL KINDS...

IF you don't see anything in this ad. that you want, write us or call and see, as we have what you do want. We are the largest manufacturers of electrical supplies in America.

MANHATTAN ELECTRICAL SUPPLY CO.,

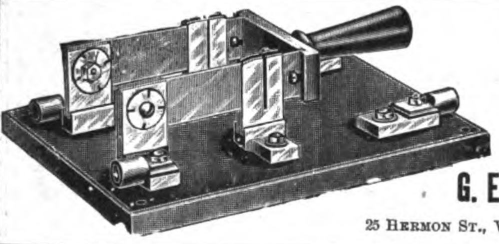
NEW YORK--32 Cortlandt St. CHICAGO--188 Fifth Ave.

When Writing to Advertisers Mention American Electrician.

WE MAKE **WHITE SWITCHES.**

Our Return Bend Contact is Not Excelled.

H. P. WHITE CO., Ltd., 1127 Appletree St., Phila., Pa.



KNIFE SWITCHES.

G. E. LINTON & CO.

25 HERMON ST., WORCESTER, MASS.

Every Character

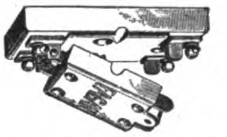
OF

Electric Heating Apparatus

IS MANUFACTURED BY

THE SIMPLEX ELECTRICAL CO.,

CAMBRIDGEPORT, MASS.



The Fagan Cut-Out and Switch.

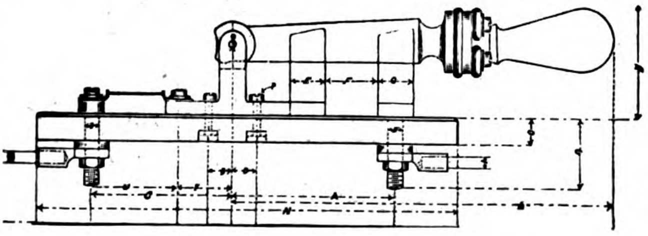
Placed on ceiling—opens and shuts with cord. For controlling either incandescent or arc lamps. Obviates running wires down walls.

......MANUFACTURED BY......

J. C. FAGAN, Watertown, N. Y.

For sale by all Supply Dealers.

HILL SWITCHES



Our Switchboard Switches are Standard of the World.

When you are in the market for a Switchboard send us your specifications. We promise you a low price.

W. S. HILL ELECTRIC CO.

NEW BEDFORD, Mass.

PITTSBURGH TRANSFORMERS

TYPE K

Type K Transformer Ready for Mounting.

Highest Electrical Efficiency

Substantial Mechanical Construction

Our three-wire type K is wound so that an unbalanced load has no disturbing effect upon the regulation.

IF YOU ARE INTERESTED SEND FOR BULLETINS AND PRICES

Suspension—Front View.

OKONITE IT NEVER DISAPPOINTS

Central Electric Company,

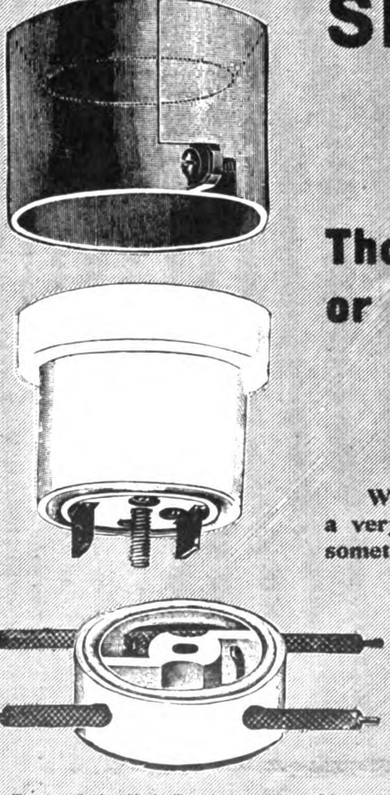
SALES AGENTS

264-266-268-270 FIFTH AVE., CHICAGO.

OKONITE IT NEVER DISAPPOINTS

BREWSTER UNIVERSAL SIGN RECEPTACLES

Patented December 11, 1900, and April 9 and 23, 1901.



Parts of the Unit Ready to Assemble.

A SYSTEM OF UNITS

From which may be quickly formed, wired and installed, anything in the shape of

Thoroughly Weatherproof Electric Signs or Electrical Decorations OF ANY STYLE OR VARIETY.

"The Connecting Link."

When through using the Receptacles in the shape of one Sign or Decoration, a very little labor only is necessary to make them up into something else—something entirely different.

JUST THE THING FOR THEATRES, OR FOR MERCHANTS WHO WANT TO KEEP ABREAST OF THE TIMES, BY ELECTRICAL ADVERTISING, AND YET REQUIRE VARIETY.

The Electric Motor & Equipment Co.

SOLE MANUFACTURERS AND SALES AGENTS,

12-14 BEAVER STREET, NEWARK, N. J.

"Pennsylvania" Incandescent Lamps

UNIFORMITY
in Initial
VOLTAGE

FULL CANDLE POWER
at Rated Voltage

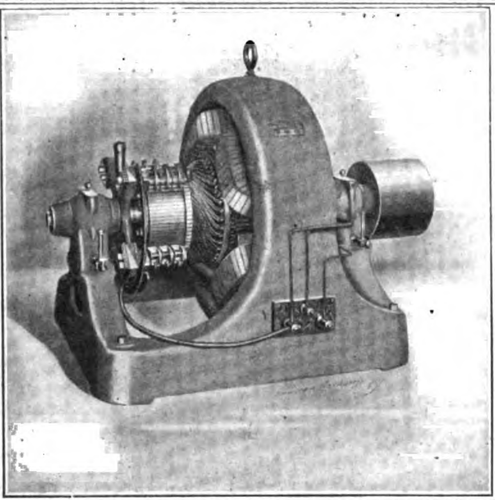
Embody all the essential features of a thoroughly high grade lamp.

The materials used in the construction of our lamps are the best that can be bought, and the workmanship is as perfect as skilled mechanics and the latest improved machinery can make it. You can depend upon our goods operating satisfactorily, and we make prompt shipments.

HIGHEST
EFFICIENCY
and
MAINTENANCE
of Initial
CANDLE POWER

We respectfully solicit business under guarantee to furnish lamps exactly as ordered. Send us a trial order for a barrel or larger quantity.

THE PITTSBURG ELECTRIC LAMP CO., Braddock, Pa.



Kentucky Electrical Co.

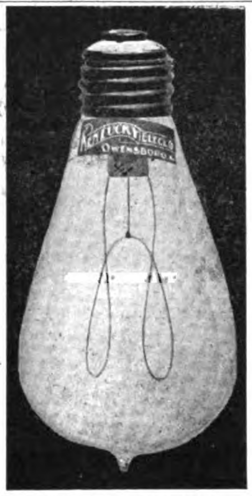
INCORPORATED,
MANUFACTURERS OF

INCANDESCENT LAMPS,
MOTORS and DYNAMOS.

OWENSBORO, KY.

**OUR GOODS ARE GUARANTEED
PROMPT SHIPMENTS.**

WRITE FOR PRICES.



NOW WE HAVE STRUCK IT

AND CAN GIVE YOU AN

ARC LAMP

UP TO DATE IN
EVERY RESPECT

DIRECT CURRENT—POTENTIAL TYPES

Write now for particulars on the

L.-H. ENCLOSED ARC LAMP.

THE ANDERSON TOOL WORKS, ANDERSON, IND.

SIGNALOID

THE MOST PERFECT AND RELIABLE

Coloring and Frosting Liquid
FOR
Incandescent Electric Lamps.

Will never peel, chip, or crack, and the color will outlive the life of the lamp.

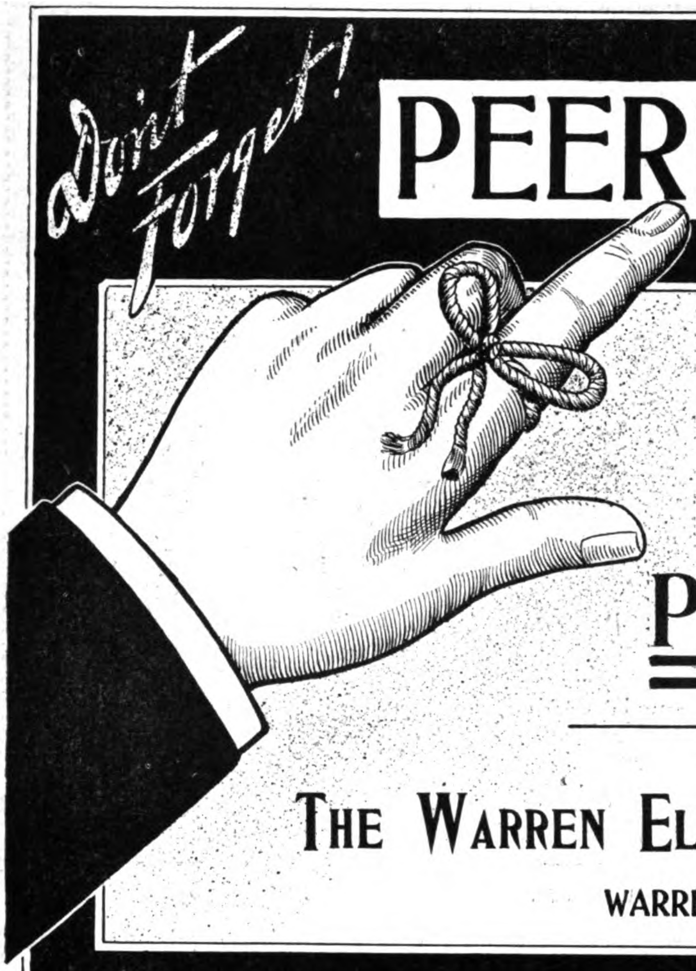
MANUFACTURED BY

Signaloid Chemical Works,
167-169 Clendenny Ave., Jersey City, N. J.

ELECTRICAL MACHINERY AND SUPPLIES

Warren Alternators
Moloney Transformers
Eddy Dynamos and Motors
Adams-Bagnall Arc Lamps
Paranite Wires and Cables
Diamond Wattmeters

WESTERN ELECTRICAL SUPPLY CO.
ST. LOUIS, MO.


Don't Forget!

PEERLESS LAMPS

A String on an Order is worth two on your finger. You won't feel as if any one had been "stringing" you if you buy

PEERLESS LAMPS

MADE BY

THE WARREN ELECTRIC & SPECIALTY CO.

WARREN, OHIO, U. S. A.

Manhattan Enclosed Arc Lamps

FOR ALL CIRCUITS

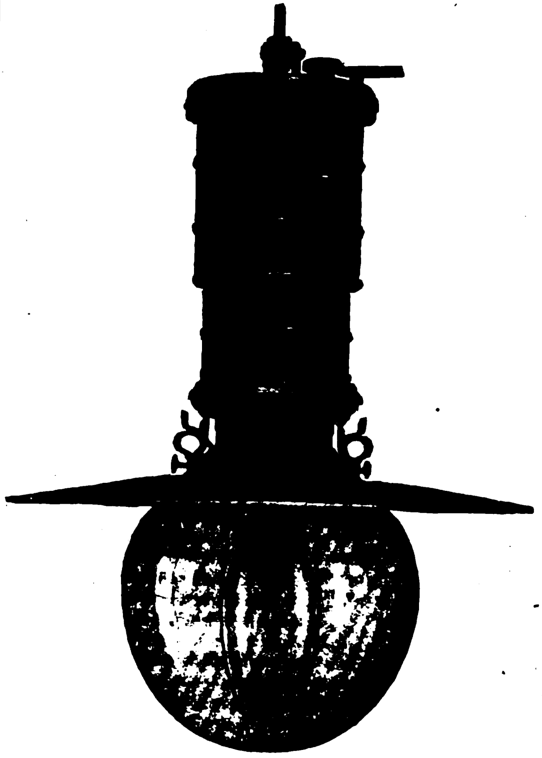
Alternating High Tension
Direct Low Tension

MANUFACTURED UNDER

Marks Enclosed Arc Lamp

PATENTS

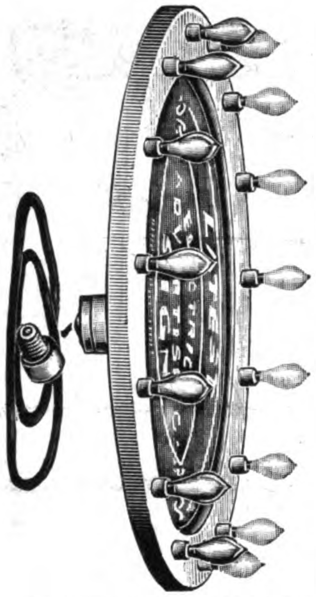
These patents broadly cover all forms of Enclosed Arc Lamps, and users will take notice that with MANHATTAN Lamps they purchase thorough patent protection. Beware of lamps made by unlicensed companies. . . . . .



MANHATTAN GENERAL CONSTRUCTION CO., NEWARK, N. J.

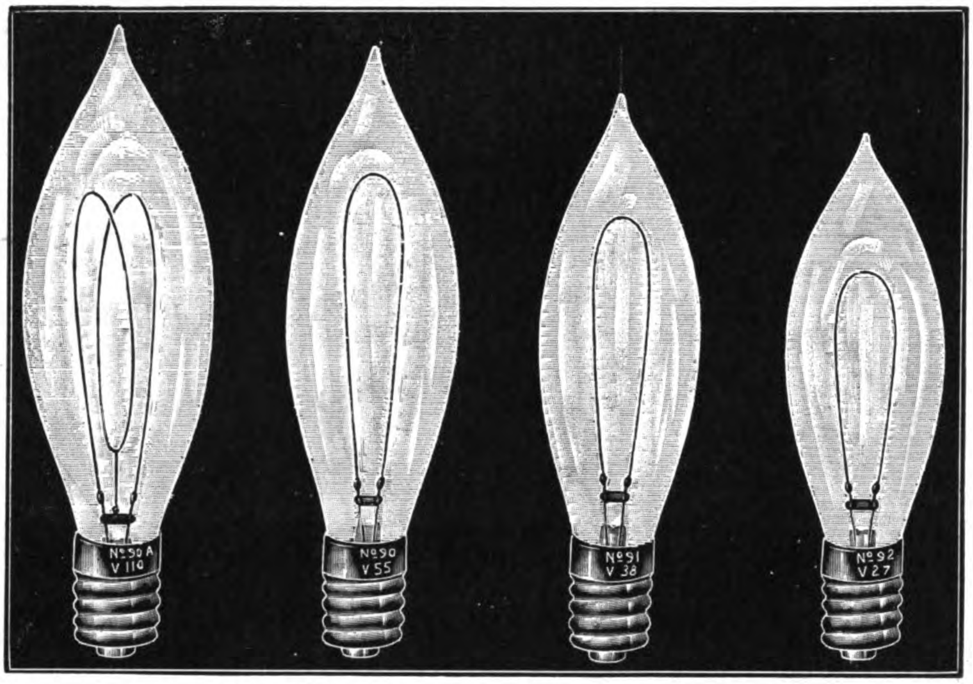
American Miniature & Decorative Lamp Co.

436 Broome Street, New York City, N. Y.



Side View of Electrical Sign.

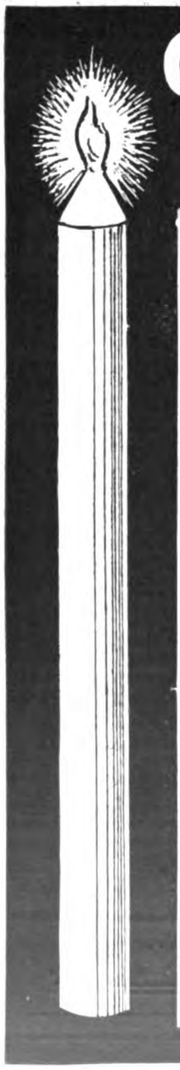
THE newest device for advertising in show windows. Lights the window while advertising the goods



Candelabra Lamps for Multiple and Series.

Comparing our Miniature Lamps in price with other makers, only for life, they are the cheapest; combining other advantages, they are still cheaper.

SEND FOR OUR NEW CATALOGUE.



ONE CANDLE POWER

costs so little that you can afford to let it "flicker" the whole evening through and avoid the annoyance of snapping switches. On the front porch, one candle power shows the street number, locates the door bell, and gets you up the steps without stumbling. A little money spent for current may save a broken leg. Costs about half a cent per evening to light the porch. When you have a party and want a bright light turn up the

HYLO

and have 16 candle power. This lamp has two filaments giving 16 or one candle power. The least little twist of the bulb turns the light up and down. Fits standard sockets.

The HYLO Lamp is absolutely essential to good electric lighting and good electric lighting is essential to good living everywhere. The central station which does not have the HYLO for its customers is a long way from the head of the procession.

Write for prices and printing.

THE PHELPS COMPANY
29 State Street, DETROIT, MICH., U. S. A.

Focusing Arc Lamps

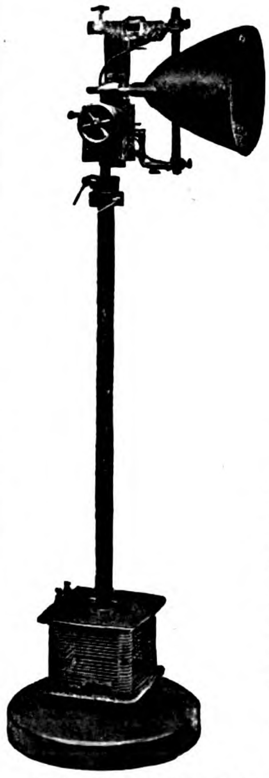


PHOTO-ENGRAVING LAMP
Time of Exposure Reduced
20 to 50 per cent.

Reflectors
Rheostats
Stands:::

FOR
Photo-Engraving
Stage Lighting
Electric Fountains
Stereopticons
Illuminating of
Decorations, Etc.

CHICAGO, July 30, 1901.

Gentlemen: In reply to your inquiry regarding the three Baker & Fox 30 Ampere Lamps which were installed in our Engraving Department the latter part of last year, we have found, after seven months' continued use, that they are working just as satisfactory as the day they were put in and have not a single complaint to make, being without doubt the best focusing lamp we have ever used for steadiness and brilliancy of light, as well as for economy in the consumption of current. Respectfully,

A. N. KELLOGG NEWSPAPER CO.

BAKER & FOX
83 Schermerhorn St.
BROOKLYN, - - NEW YORK

ECONOMY
INCANDESCENT
LAMPS

4, 6, 8, 10, 16
and 20 C. P.
13 cents each.
Rebate 3c. each for
equal number returned, freight paid.

THE ECONOMY
ELECTRIC COMPANY,
Warren, Ohio, U. S. A.

SENT "ON SUSPICION."

PRACTICAL
ELECTRIC RAILWAY HAND BOOK
By ALBERT B. HERRICK

This is a book especially compiled for the use of Street Railway engineers, electricians and employees. It is a collection of the data necessary for the construction, designing, testing and operating of the different parts of a street railway system. For convenience this book is divided into nine sections.

SECTION I
GENERAL TABLES.
Weights and Measures
SECTION II
TESTING.
Methods of Measuring Resistance, Potential and Current
SECTION III
THE TRACK.
Cost of Construction.
SECTION IV
THE STATION.
General Station Arrangement.
SECTION V
THE LINE.
Methods of Line Construction.
SECTION VI
THE CAR BARN.
Rules.
SECTION VII
THE REPAIR SHOP.
Methods of Handling Equipment.
SECTION VIII
THE EQUIPMENT.
Braking Methods and Rigging.
SECTION IX
THE OPERATION.
Schedules and Speeds.

No effort has been spared to make the work as free from errors as possible, and as a hand book to bring it down to as condensed a volume as possible. The matter has been largely selected from data collected during the past twenty years by the author, it being abridged and brought up-to-date.

Handsomely Bound for the Pocket, with Flap
300 Pages, Numerous Illus. Price, $3.00

American Electrician Co.
120 LIBERTY ST., NEW YORK

BANNER LAMPS

Lead to Better Light.

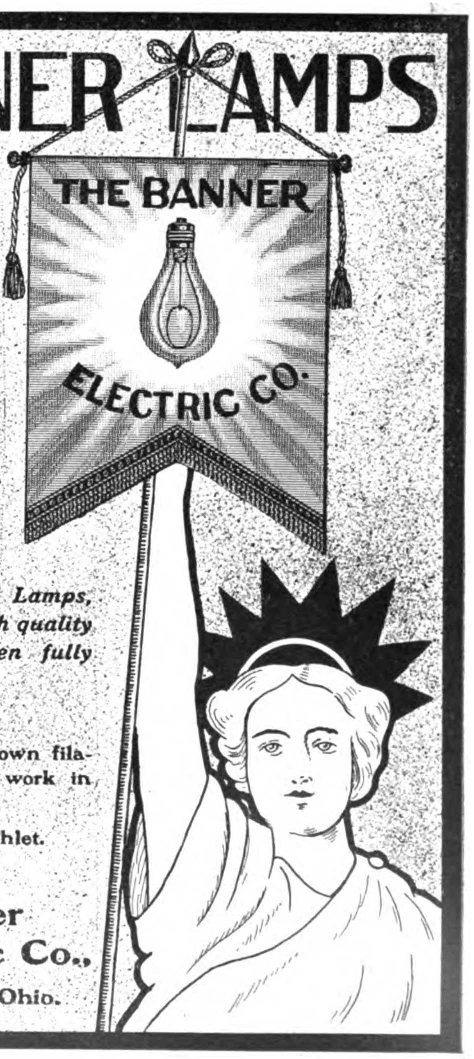
Made in Strict Conformity with the well defined lines within which all First Class Lamps must be considered in order to give satisfactory service.

No Experimental Lamps, but lamps, the high quality of which has been fully demonstrated.

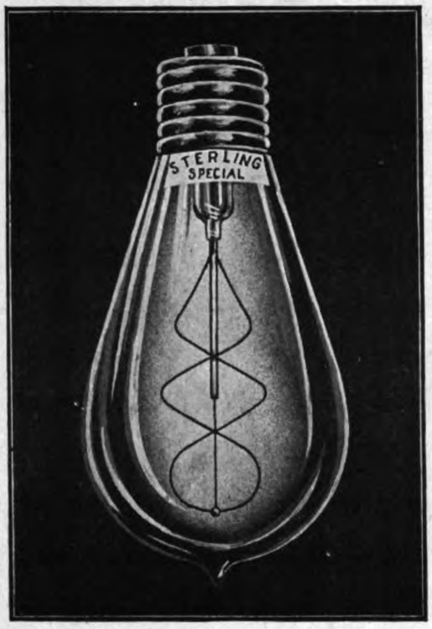
We make all our own filaments. No guess work in our factory.

Write for pamphlet.

The Banner
Electric Co.,
Youngstown, Ohio.



EQUAL LIGHT



The Sterling Special Incandescent Lamp

has solved the problem of perfectly symmetrical distribution of light in every direction.

The diagrams below show the results of photometric measurements taken from the principal types of filaments now in use.

See the perfectly uniform distribution of light secured by the special spiral filament of the Sterling Lamp in Fig. 4.

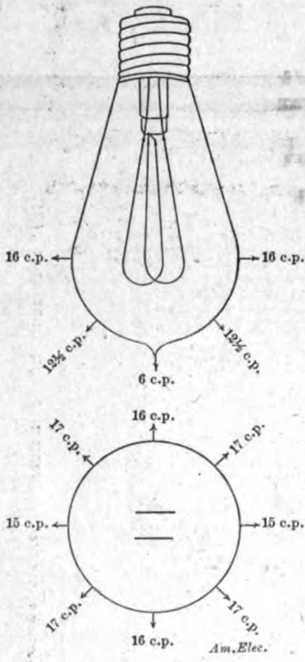


Fig. 1.

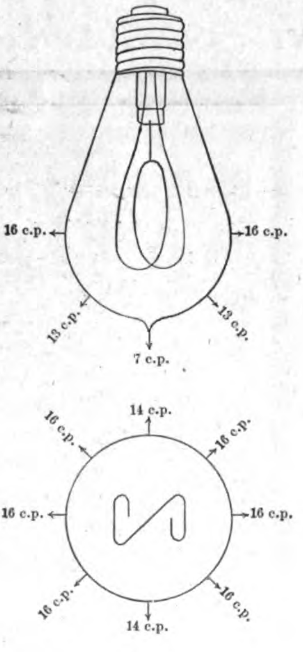


Fig. 2.

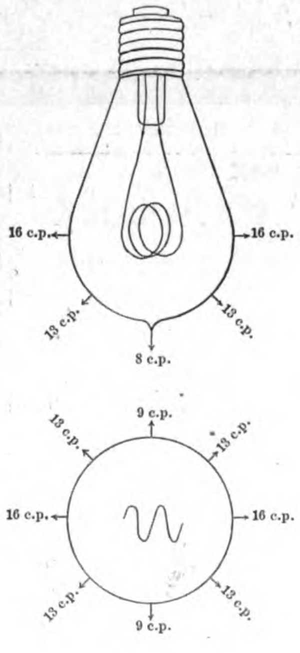


Fig. 3.

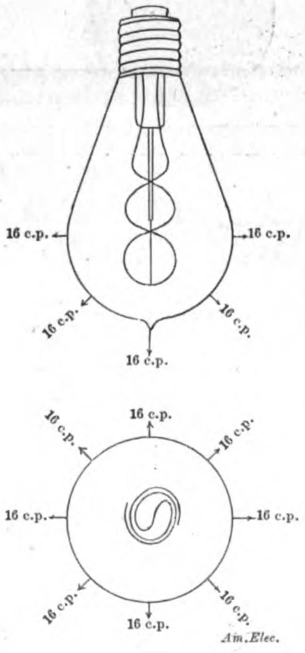


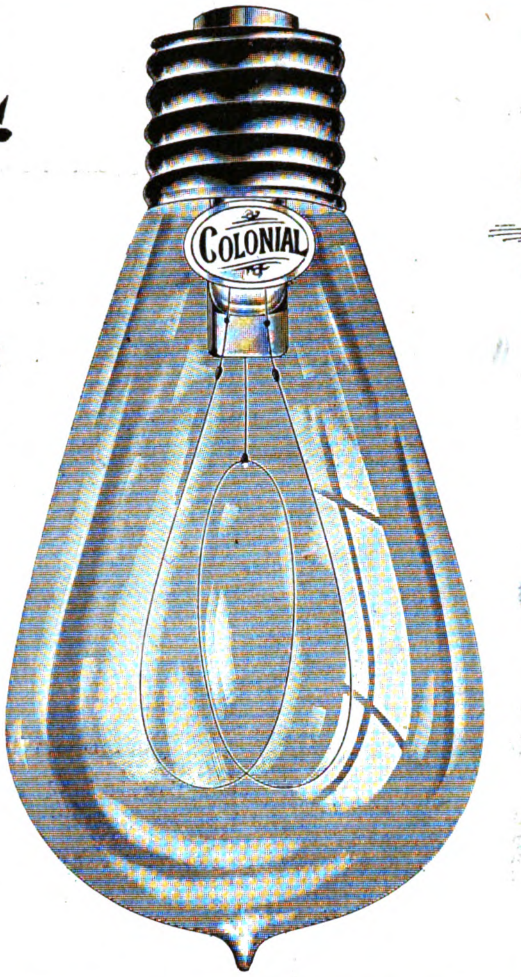
Fig. 4.

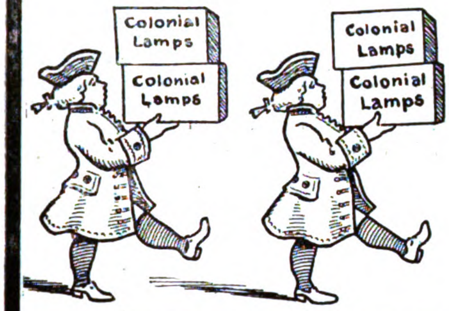
WE GUARANTEE EQUAL LIGHT, REGULAR LIGHT, MAINTENANCE OF CANDLE POWER, SATISFACTORY LIFE, CLOSENESS OF ASSORTMENT.

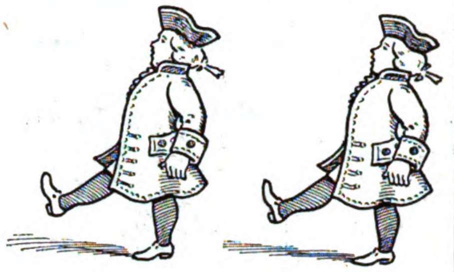
THE STERLING ELECTRICAL
MANUFACTURING CO.
WARREN, OHIO.
New York Office, 26 Cortlandt St. Francis Granger, Agent.

COLONIAL LAMPS

Represent the highest degree of excellence possible in Incandescent Lamps.







A trial lot will convince.

Manufactured by

The Colonial Electric Co.

Ravenna,
Ohio, U.S.A.

RECENT TYPES OF

Dynamo-Electric Machinery

.... BY ....

EDWIN J. HOUSTON, Ph.D., and A. E. KENNELLY, Sc.D.

Cloth. 612 Pages. 435 Illustrations. Price, $5.00

Although many books have been written on the subject of dynamo-electric machinery, yet, so far as the authors are aware, none have yet appeared that have been devoted *entirely to American types of machines;* or, at least, none in which these have been treated from an entirely practical standpoint, with copious illustrations, enabling the reader to form precise ideas concerning the exact appearance, function and behavior of American machines. The book is not a treatise concerning the principles of dynamo-electric machinery, or the theory of its operation, but a descriptive treatise of the various types of machines made by different manufacturers, with their sizes, data, functions and capabilities.

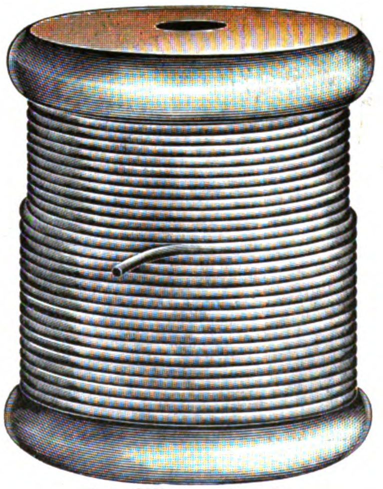
In describing the various machines, attention has particularly been given to the practical rather than to the theoretical side of the subject. For this reason the book is readily capable of comprehension by those who have not had collegiate training, and is not limited, as many books on dynamo-electric machinery necessarily are, to those skilled in electrotechnics.

Copies of this or any other electrical book published will be sent by mail, postage prepaid, to any address in the world, on receipt of price.

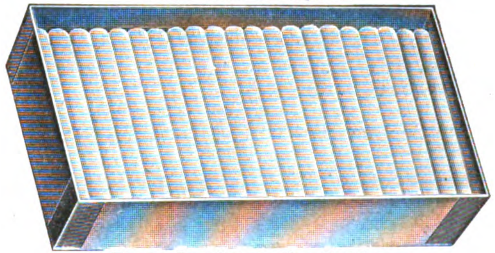
AMERICAN ELECTRICIAN CO.

120 LIBERTY STREET, NEW YORK

WIRE JOINTS



Fuse Wire on Spools



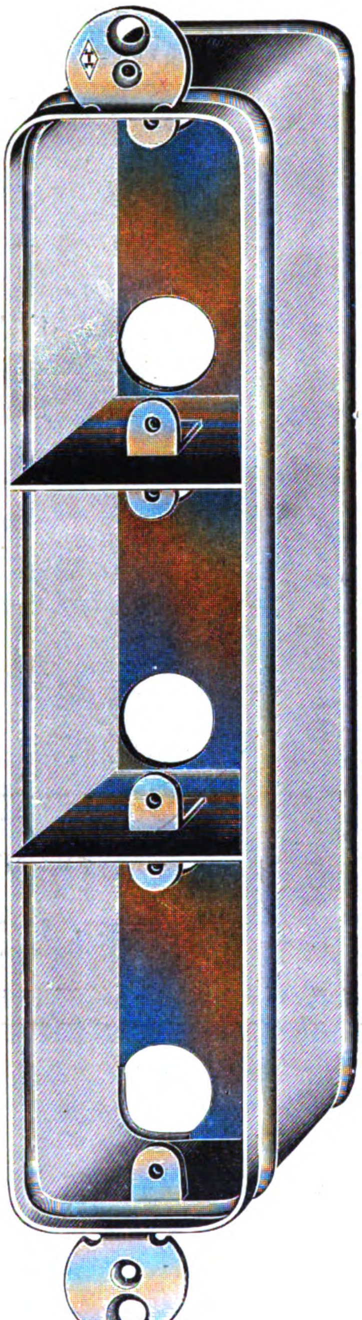
Paper Insulators for Cables
Packed 110 in a box

SEE OUR PRICES BEFORE BUYING

American Electric Fuse Co.

NEW YORK
116 Nassau St.

CHICAGO
345-347 S. Canal St.



No. 3 Tandem Case for Push Button or Rotary Switches

"DIAMOND H" STEEL WALL CASES

For Rotary and Push Button Switches, Single Switches or Gangs, Horizontal or Vertical (Tandem) Gangs.

See Sec. 22, par. d, 1901 Natl. El. Code.

Automatic Door Switch

SOMETHING NEW

THE HART MFG. CO., HARTFORD, CONN.

NEW YORK . . . Wm. Taylor . . . . . 203 Broadway.
BOSTON . . . . . F. B. Smith . . . . 170 Summer St
CHICAGO . . . W. P. Crockett . . . 315 Dearborn St.

HIGH-GRADE SWITCHBOARDS

Arc Light Enclosed Fuses.

Cartwright Enclosed Fuses

Are absolutely reliable and a perfect protection to Lighting and Power Circuits of 2,000 volts and under.

The only Enclosed Fuse manufactured under the fundamental patent of Wm. M. Mordey.

WRITE FOR

Enclosed Fuse Department Bulletin No. 18.

Fuse Wire and Fuse Link Department, Bulletin No. 11.
Junction Box Department, Bulletin No. 9 and No. 13.
Knife Switch " " No. 10.
Cushing Theatre Switchboard Department, Bulletin No. 14.
Electrical Repairing Department, Bulletin No. 15.
Bottle Labeling Machines, Bulletin No. 16.
Rail Bonds, Bulletin No. 17.
Switchboards, Bulletin No. 19.

CHASE-SHAWMUT CO.
ELECTRICAL SPECIALTIES
BOSTON.

No. 2861

SILVER MEDAL

AWARDED AT THE

PAN-AMERICAN EXPOSITION.

FRINK'S GREAT CHURCH LIGHT

Installed in Over 20,000 Churches

This light is made in a large variety of sizes and styles, and special designs are prepared by experienced designers to correspond with any style of decoration.

All these chandeliers are fitted with Frink's Silver Plated Corrugated Glass, the best known reflector of light.

For theatres, music halls, etc., our double cone reflecting prismatic sun-lights, made in all styles from the plainest to the most ornate of designs, are unequaled.

Estimates free upon receipt of plans, or full information concerning size and shape of auditorium.

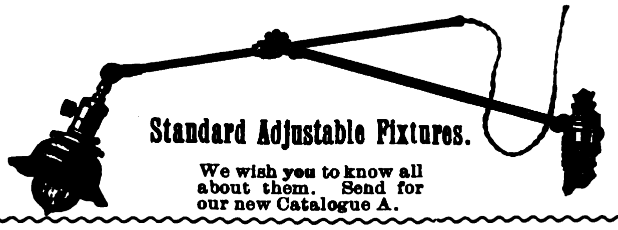
"BOOK OF LIGHT" and Estimates Sent Free

GEO. FRINK SPENCER, Manager

Telephone "860 Franklin"
Cable Address "Frink, New York"

I. P. FRINK 551 Pearl St., NEW YORK

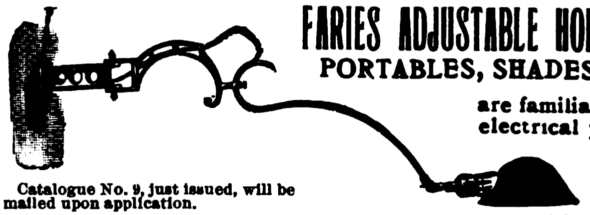
Licensed to Manufacture Electric and Combination Fixtures.



THE O. C. WHITE CO., Worcester, Mass.

Standard Adjustable Fixtures.

We wish you to know all about them. Send for our new Catalogue A.



FARIES ADJUSTABLE HOLDERS,
PORTABLES, SHADES, Etc.,
are familiar to all electrical people.

Catalogue No. 9, just issued, will be mailed upon application.

FARIES MANUFACTURING CO., DECATUR, ILL.

MURRAY FLINT GLASS GLOBES and SHADES

We manufacture Arc and Incandescent Globes and Shades of all Shapes in Opal, Clear, Roughed and Colored. Large capacity. Prompt Shipment.

James J. Murray & Co., Trenton Ave., Culvert and Waterloo Sts., -- PHILADELPHIA, PA.

SEND FOR CATALOGUE

(FOURTH EDITION)

ELECTRICAL BOOKS,

NOW READY.

120 Liberty St., - AMERICAN ELECTRICIAN CO.

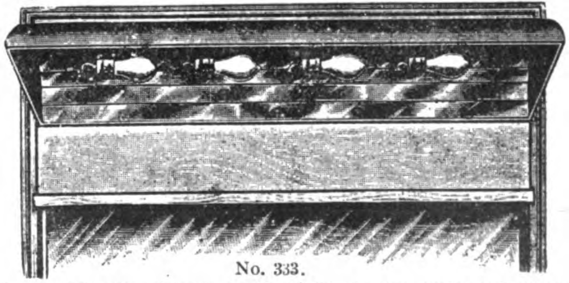
In writing to advertisers please mention
AMERICAN ELECTRICIAN :: :: ::

LET US REFLECT.

Good goods in a store window poorly shown are even worse than poor goods well displayed.

LIGHT YOUR WINDOW.
Get the greatest possible refractivity from your lights by using our

PARAGON REFLECTORS.



No. 333.

They can be placed to throw the light at any angle and cover the entire window with an even light. Made in lengths to fit any window. Send for prices and catalogue.

American Reflector & Lighting Co., Chicago, Ills.

"STELLARC" The Best Arc Lamp Made

JOHN A. HAMBLIN
12 Beverly St., Providence R.I.

GENERAL ELECTRIC COMPANY'S

Railway Apparatus and Supplies

FOR THE POWER HOUSE AND SUB-STATION.

Ammeters
Alternating Current Generators, all sizes, belted and direct connected
Automatic Circuit Breakers
Cables, all kinds
Cable Terminals
Direct Current Generators, all sizes, belted and direct connected
Exciter Sets
Expulsion Fuse Boxes
Floor Insulators
Friction Tape
Fuses
Ground Detectors
Insulators
Insulator Racks
Instruments of all kinds
Lamps, Arc, Incandescent
Lightning Arresters
Oil Switches
Pedestal Switches
Potential Plug Receptacles
Pilot Lamp Fixtures
Repair parts for Generators
Rheostats
Rotary Converters
Sockets and Receptacles
Splicing Gum
Switchboard Panels
Transformers
Voltmeters
Voltmeter Switches
Wall Insulators
Wattmeter, Recording and Indicating
Wire, Insulated and Bare

FOR THE LINE.

Braces
Brackets
Cables
Ceiling Ears
Channel Pins
Cross Arms
Crossings
Ears
Feeder, Wire and Cable
Feeder Clamps
Feeder Ears
Fork Bolt
Friction Tape
Fuses
Grooved Trolley Wire
Hauling Clamp for Wire
Insulators
Lamps, Arc, Incandescent
Lightning Arresters
Mining Suspensions
Pins
Section Insulators
Section Switch Boxes
Soldering Copper
Splicing Sleeves
Strain Ears
Strain Insulators
Suspensions
Third Rail Insulators
Tighteners for Wire
Tongs for Cap and Cone
Trolley Wire
Turn Buckles

FOR THE CAR.

Automatic Circuit Breakers
Cable Terminals
Car Recording Wattmeters
Car Wiring Cables
Cleats, Wood, Brass
Contact Plows
Contact Shoes
Controllers for single, double and four motor equipment, with and without Electric Brakes
Electric Brakes
Friction Tape
Fuse Boxes
Fuses
Incandescent Lamps
Lamp Clusters
Lightning Arresters
Motor Switches
Pinions
Railway Motors, all sizes and gauges
Repair parts for Motors
Resistance Boxes
Rheostats
Sockets
Splicing Gum
Steel Gears
Switch and Fuse Boxes
Third Rail Shoes
Tow Car Couplers
Trolley Poles, Wheels, Forks, Bases

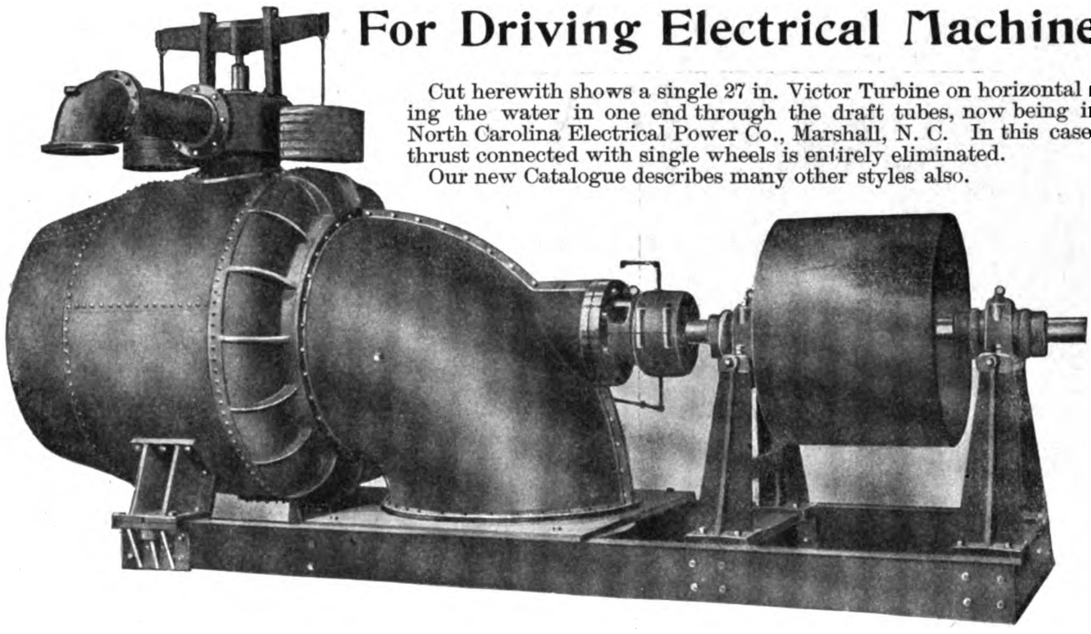
NEW YORK OFFICE
44 BROAD STREET

GENERAL OFFICE
SCHENECTADY, N. Y.

SALES OFFICES
IN ALL LARGE CITIES

VICTOR TURBINES

For Driving Electrical Machinery.



Cut herewith shows a single 27 in. Victor Turbine on horizontal shaft, discharging the water in one end through the draft tubes, now being installed by the North Carolina Electrical Power Co., Marshall, N. C. In this case the usual end thrust connected with single wheels is entirely eliminated.
Our new Catalogue describes many other styles also.

WE ALSO BUILD
Steam,
Power,
AND
Electric
Pumping
Machinery,

Feed Water Heaters, Air Compressors, Oil Mill Machinery, and Filter Presses.

If interested, address **THE STILWELL-BIERCE & SMITH-VAILE CO., 259 Lehman St., DAYTON, OHIO, U. S. A.**

311 Dearborn St., Chicago. 141 Broadway, New York. 73 Oliver St., Boston. 612 Arch St., Phila. 304 Hennen Bldg., New Orleans.
F. Nell, Sales Agent, 97 Queen Victoria St., London, E. C., Eng.

The American Electrical and Maintenance Co.,

122, 124, 126, 128, 130 Center St., New York City.

MECHANICAL and ELECTRICAL ENGINEERS

Electrical Repair Work.
Maintenance by Contract.

Shops Open Days, Nights and Holidays. Inspection Invited.

MARINE WORK A SPECIALTY.

MICA
MICANITE
EMPIRE CLOTH AND PAPER
M. I. C. COMPOUND

QUALITY THE BEST
PROMPT SHIPMENTS
LOW PRICES
LARGE STOCK

AWARDED GOLD MEDAL, PARIS, 1900

EUGENE MUNSELL & CO., FIRST HANDS
MICA INSULATOR CO. ORIGINATORS
CHICAGO AND NEW YORK

NEW MODEL "G"

Small and light weight. Accuracy guaranteed for three years. Send for description, and investigate merits of our instrument.

Stanley Instrument Company.

General Sales Office: 146 Broadway, New York, N. Y.

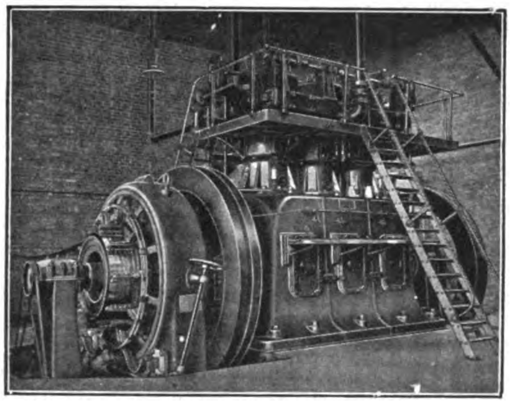
Pacific Coast Agency: 33 New Montgomery St., San Francisco, Cal.

Incandescent Lamps

Sawyer-Man Electric Co.

510-530 West 23d Street, New York

Entire Power Plants from inception to completion under one responsibility.



Westinghouse 3-Cylinder Gas Engine Direct-Connected to Generator.

Westinghouse, Church, Kerr & Co.

Engineers

New York, Chicago, Boston, Pittsburg,
Philadelphia, Detroit.

Steam Turbines, Heating,
Steam Engines, Ventilation,
Gas Engines. Mechanical Draft.

Sell the product of

The Westinghouse Machine Co.

Pittsburg——Manufacturers——Chicago

Write nearest office of Westinghouse, Church, Kerr & Co.

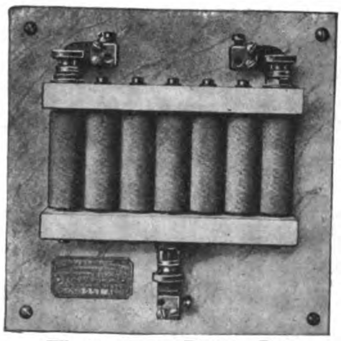
Westinghouse

Lightning Arresters

Protect Valuable Electric Apparatus.
Absolutely Non-Arcing.
Prevent Generator Current from following in path of Lightning Discharge.

Westinghouse Electric & Manufacturing Co.

Pittsburg, Pa.



Westinghouse Double-Pole Non-Arcing Metal Station Arrester. For 2,500 Volt Circuits.

Westinghouse

Motor Driven Air Compressors

for Traction Brake Service

CONSTRUCTION:
Compact,
Durable,
Dust and Waterproof.

OPERATION:
Reliable,
Highly Efficient,
Self-Lubricating.

SOLD BY

Standard Traction Brake Co.

120 Liberty St., New York City

IT'S A GOOD TIME

To look into the LEAKS in your steam plant.
IMPROVED ROBERTSON-THOMPSON INDICATOR tells you at all times if engine is developing full power for fuel consumed. Special prices July and August.
HINE ELIMINATOR frees your steam from water—keeps oil out of boiler.
EUREKA PACKING gives more power—saves one-third in a year's run. 66 page catalog for the asking.
JAS. L. ROBERTSON & SONS, 209 Fulton St., New York. Branches: Boston, Phila.

Thorough Inspections

....AND....

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO. HARTFORD, CONN.

INSURANCE AGAINST LOSS OR DAMAGE TO PROPERTY AND LOSS OF LIFE AND INJURY TO PERSONS CAUSED BY

STEAM BOILER EXPLOSIONS

J. M. ALLEN, President.
WM. B. FRANKLIN, Vice-President.
F. B. ALLEN, Second Vice-President.
J. B. PIERCE, Secretary.
L. B. BRAINERD, Treasurer.
L. F. MIDDLEBROOK, Asst. Secretary.

This Adv. is Worth $1.00 To You if you mention this paper.

If you will send a postal money order for $2.00 we will send you a pair of Donnelly's Steel Climbers and **GIVE YOU** a $1.00 Set of Straps with Pads.

Each Spur is **OIL TEMPERED** by the Wallace Barnes Co. and warranted by us.

Testimonial of the Grand Treasurer of the International Brotherhood of Electrical Workers:

I have always found the Donnelly Climbers satisfactory. *I have used them and can recommend them as second to none.*
F. J. Sheehan, Hartford, Conn.

J. J. REIDY & CO., 311-319 East Street, New Haven, Conn., U. S. A.

When writing to Advertisers mention American Electrician.

If you want an article that will repeat itself, try
U. S. METAL POLISH
For polishing all kinds of metals. Sold by Dealers. Samples free.
GEO. W. HOFFMAN, Mfr., 295 E. Washington St., Indianapolis, Ind

Sterling Extra Insulating Varnish.

Sterling Extra Black Finishing Varnish.
Sterling Black Air Drying Varnish.
Sterling Black Core Plate Varnish.

THE STERLING VARNISH CO., Pittsburgh, Pa., U. S. A.

SPRINGS

All Small Springs Used by Electrical Supply Dealers...

The Wallace Barnes Co.
Established 1857. :: BRISTOL, CONN.
Submit samples and write for prices.
Our Catalog A is interesting.

When writing to advertisers, please mention the American Electrician.

To Earn More! Learn More!

To the patrons of the American Electrician, we will supply **"HAWKINS' STANDARD WORKS FOR ENGINEERS,"** consisting of six volumes, price $11.00, on monthly payments of $1.00 each.

HAWKINS' EDUCATIONAL WORKS 6 VOLUMES ON EASY PAYMENTS DELIVERED COMPLETE MONTHLY $1

Cut this Out

a/ **Theo. Audel & Co., New York City.** ....1901.
I accept your proposition to supply **"Hawkins' Works"** on monthly payments. So consider the inclosed $1 my first payment, and send me the books, express paid, and I agree to send you $1 each month until the amount of pu chase is paid.
Signature..
Place of business.......................... Residence..
I can refer you as to my reliability to
Name.............................. Address..

	Price,
Hawkins' New Catechism of the Steam Engine.	$2
" New Catechism of Electricity(leather, Pocket-book form)	" 2
" Aids to Engineers' Examinations, with Questions and Answers	" 2
" Maxims and Instructions for the Boiler Room,	" 2
" Handbook of Calculations for Engineers	" 2
" Indicator Catechism	" 1

UP-TO-DATE & PRACTICAL BOOKS FOR Home Study

EACH VOLUME is complete in itself, and one book or more will be supplied and sent postpaid upon receipt of order.

Taken as a whole the six books make a complete engineer's library of life-long value.

The books are strongly and handsomely bound and printed on fine smooth surface paper. They are plain books, carefully edited for the practical man, and each book is provided with a ready reference index.

These easy terms of payment place this set of books within the reach of all; and, again, if they are not satisfactory after examination, they can be returned and the money paid will be refunded.

Money can best and most safely be sent by P. O. money order.

THEO. AUDEL & CO., Publishers, 63 Fifth Ave., New York.

HELP WANTED.

LARGE WHOLESALE HOUSE intends to establish an Office and distributing depot in each State, and desires Manager for each office. Salary $125 per month and extra profits. Applicants must furnish reference as to character and have from $800 to $1000 cash. Previous experience not necessary. For particulars address PRESIDENT, Box 1151, Philadelphia, Pa.

A COMPETENT ELECTRICAL ENGINEER who has had experience in designing large and small dynamos and motors. Only a man thoroughly competent to take charge of entire details, with gilt-edge reference, need apply. We also want a reliable man who thoroughly understands ARMATURE WINDING. Address "DYNAMOTOR," care AMERICAN ELECTRICIAN, Monadnock Block, Chicago, Ills.

ELECTRICAL ENGINEER wanted in Pittsburg for small machinery and appliance designing and electrical wiring diagrams for light and power. Young man preferred who has had some practical experience. Must be thoroughly versed in mechanical drawing and have a good technical training, obtained either at school or by individual studies. Must state age, time spent in studies, graduated or not, and if so, from what school and salary wanted. Address "ENGINEER," care AMERICAN ELECTRICIAN, New York City.

FOR SALE.

ONE 50 LIGHT, 2000 CANDLE POWER STANDARD ARC DYNAMO, with extra new armature. One 25 k. w. 500 volt General Electric Multipolar Generator, and one 25 k. w. 500 volt General Electric Multipolar Motor. Address A. M. BARRON, 164 Dearborn Street, Chicago, Ill.

FOR SALE.

1—100 Horse-power direct current belted type 500-volt Moderate Speed Motor.
1— 40 Horse-power direct current belted type 500-volt Moderate Speed Motor.

Manufactured by the Westinghouse Electric & Mfg. Co.

These machines were used less than ten months to operate a flouring mill; are in first-class condition and ready for immediate delivery. For further particulars address

THE LEE-WARREN MILLING CO., Salina, Kansas.

Steam Power Plant for Sale.

One 13 x 22-30 Vilter cross compound Corliss condensing engine.
One 8-in. Baragwanath syphon condenser with 8-in. pipe.
One No. 13 American feed water heater.
One No. 10 Lucas boiler feed power pump.
Two Jones underfeed stokers.
One H. T. boiler 60 x 16, 125 lbs. pressure.
Two H. T. boilers, 54 x 14, 100 lbs. pressure.

......Address......

H. M. NEWTON, Sparta, Wis.

ENGINEER'S LICENSE. Mechanics, Engineers, Firemen, Electricians, Etc.

40-page pamphlet containing questions asked by Examining Board of Engineers.

SENT FREE. GEORGE A. ZELLER, Publisher, Room 334, 18 So. 4th St., St. Louis, Mo.

When Writing to Advertisers Please Mention The American Electrician.

Electrical and Steam Machinery.

1—100-kw Westinghouse 8-pole. 225 r. p. m., direct-connected to McIntosh & Seymour comp. engine. 110 volts.

RAILWAY GENERATORS. BELTED.

4—300-kw General Electric.
1—225-kw General Electric.
3—100-kw General Electric.
1—100-kw Edison.
2—75-kw Thomson-Houston.
2—D62 Thomson-Houston.
2—60-kw Edison.

BOILERS.

2—375-hp Sterling boilers, 150 lbs. pressure.
7—125-hp Ames return tubulars.
2—500-hp Hazelton vertical boilers.

ENGINES.

1—36 x 72 Wheelock engine.
2—30 x 60 Harris Corliss engines with band wheels; speed, 62 r.p.m.
1—29 x 72 Wheelock engine.
1—20 x 48 Corliss.
1—10 x 24 Harris Corliss.
1—20 x 36 x 48 Tandem Hamilton right hand with wheel 22 ft. diam. x 56-in. face.
1—18½ x 18 centre crank Ideal engine, speed 220 r.p.m.; driving wheel 7 ft. 6 in. diameter by 25-in. face.
4—12 and 20x12 comp. West'house.
1—16 and 27 x 16 comp. West'house.
1—18½ x 18 Armington & Sims.
2—16 x 16 Ames.
2—11 x 12 Ames.
2—16 x 16 Erie Ball.
3—15½ x 15 Armington & Sims.
1—14 x 13 Armington & Sims.
2—13 x 14 Watertown.
2—13 x 12 Ball automatic.
2—12 x 12 Erie Ball.

STACK.

1—Self-sustaining steel stack, 7 ft. dia. x 125 ft. high.

Large Stock of Alternators, Arc Dynamos, Motors, Street Cars and Railway Equipments constantly on hand.

ROSSITER, MAC GOVERN & CO., 141 BROADWAY, NEW YORK CITY.

SEND FOR CATALOGUE. Factory: Jersey City.

LOUIS HECK, SUCCESSOR TO STUCKY & HECK,

ELECTRICAL MANUFACTURING CO., LIM'D,

Electrical and Mechanical Engineers and Draughtsmen.

Every System—Repairing, Re-winding, Re-construction.

35 N. J. RAILROAD AVENUE, Opp. Market St. Railroad Depot, NEWARK, N. J.

TELEPHONE No. 977.

JACOB STUCKY, 17-19 Alling St., NEWARK, N. J.

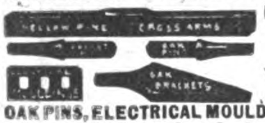
L. D. Telephone, 3052.

Practical Electrical Machinist.

Dynamos, Motors, Armature Winding, Commutators of any manufacture refilled.

23 years' experience managing the construction of Electrical Machinery.

Central Manufacturing Co.



Chattanooga, Tenn.

Manufacturers and Dealers in

YELLOW PINE CROSS ARMS, LOCUST PINS, OAK PINS, ELECTRICAL MOULDINGS, OAK BRACKETS.

Large stocks on hand. Delivered prices quoted. F. O. B. cars, your city, in any quantity. *Write us.*

"Something New and Convenient."

THE DOME ELECTRIC MASSAGE BATTERY,

For Physician, or patient, Home Use or Traveling, is the best and most convenient form of battery ever produced. Its currents are smooth and even, and their strength can be graded from the mildest perceptible to a power few can endure. Complete battery is contained in a highly ornamental aluminum case, with all modern improvements, including a massage roller. Price, complete $3.00. Agents wanted. Stamp brings catalogue. **The Dunn Electric Co., 75-77 Nassau St., New York.**

We make a specialty of **Armature, Field and Transformer Winding.**

We maintain a first-class repair shop and can guarantee prompt service. Electrical Construction and Supplies of every description.

Bruce-Hibbard Electric Co., Fitchburg, Mass., 5 Oliver St.

EVERY issue of the AMERICAN ELECTRICIAN is filled with important and timely articles reflecting the latest advances in both electrical and steam engineering and practice, the aim being always to present matter of *real* intrinsic value to everyone interested in electricity and its applications.

ARMATURES REWOUND
COMMUTATORS REFILLED
Carefully and Promptly.

AGENTS FOR KEYSTONE ELECTRIC CO DYNAMOS & MOTORS

Stewart Electrical Co.

BUY AND SELL

S.E. COR FIFTH & SYCAMORE STS CINCINNATI, O.

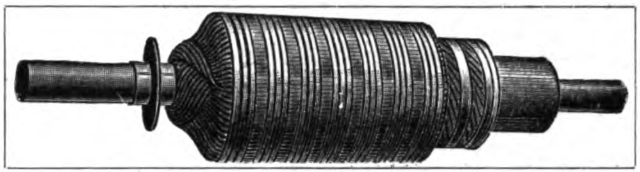
SECOND HAND ELECTRICAL MACHINERY.

Write for our List of
Machines,
Instruments, and
Extra Armatures.

The Van Dorn-Elliott Electric Co.,

General Machinists and Electrical Repairers.

Armature Winding and Building.
Commutator Filling and Building.



Transformers and Fields of all Types Rewound.

Unequaled Facilities for Handling Heavy Work and for doing Direct-Connected and Heavy Work outside that cannot be shipped to us.

Electrical and Mechanical Perfection. CLEVELAND, OHIO.

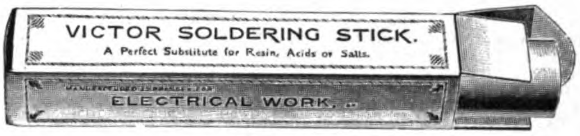
The G. & E. Boring Machine for Electricians.

A GREAT LABOR SAVER.

Saves at least 50 per cent. labor in boring holes; wires can be pulled through many holes; it saves wire; it saves the insulation. You need no stepladder for boring holes. If you want to control the wiring in your town, write for prices, etc., to the

G. & E. ELECTRIC CO.,
BINGHAMTON, N. Y.

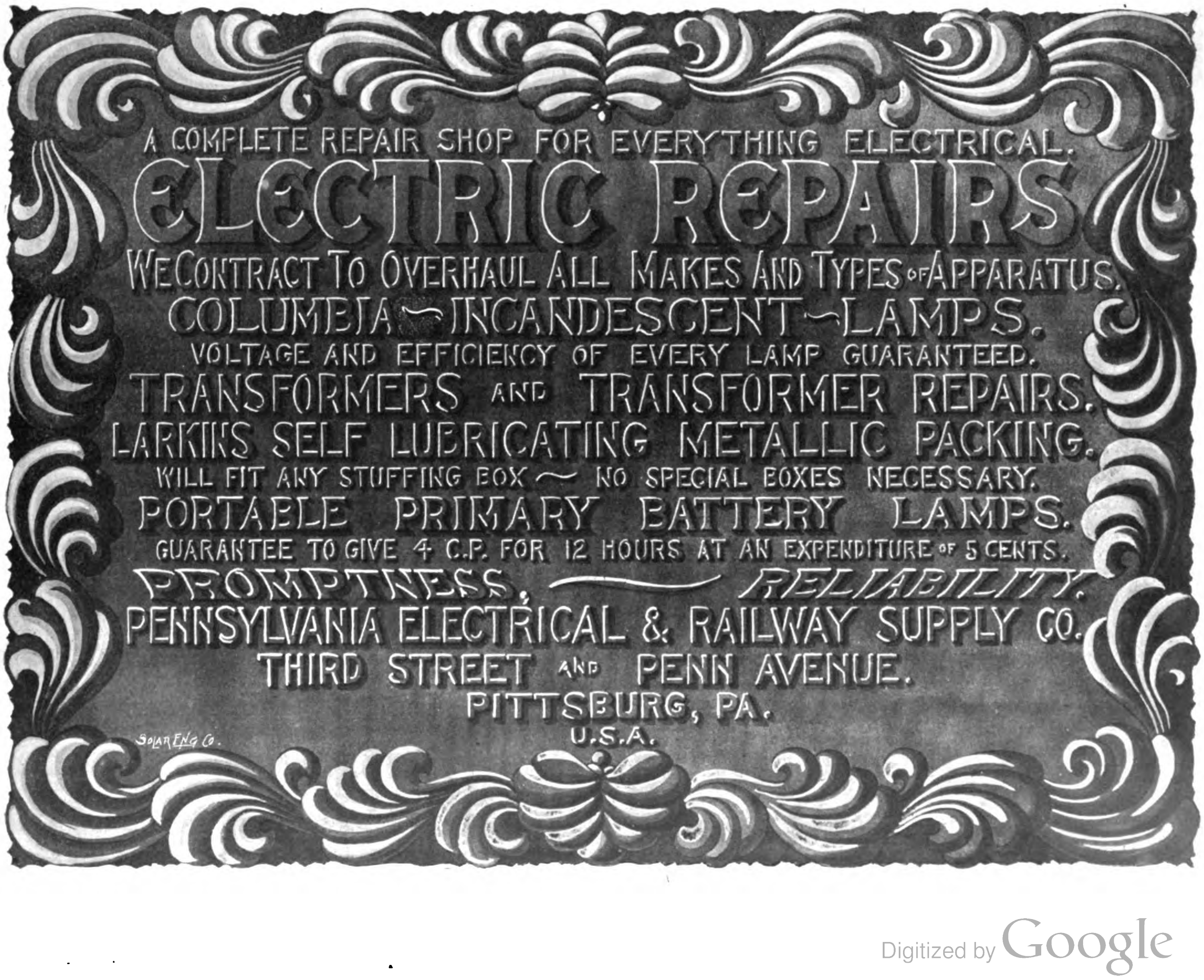
Victor Soldering Stick.


VICTOR SOLDERING STICK.
A Perfect Substitute for Resin, Acids or Salts.
ELECTRICAL WORK.

THE STANDARD FOR ELECTRICAL USE.

For making a sound, quick and durable joint it stands absolutely without a rival. *It will not splutter nor corrode.*
Each stick has a close fitting pasteboard tube over the tinfoil, preserving its shape and making it the cleanest and easiest handled soldering flux in existence. Buy from your regular supply house or write us. Samples free.

ANCHOR CHEMICAL COMPANY, No. 541 Gates Avenue, BROOKLYN, N. Y.



A COMPLETE REPAIR SHOP FOR EVERYTHING ELECTRICAL.

ELECTRIC REPAIRS

WE CONTRACT TO OVERHAUL ALL MAKES AND TYPES OF APPARATUS.

COLUMBIA — INCANDESCENT — LAMPS.

VOLTAGE AND EFFICIENCY OF EVERY LAMP GUARANTEED.

TRANSFORMERS AND TRANSFORMER REPAIRS.

LARKINS SELF LUBRICATING METALLIC PACKING.

WILL FIT ANY STUFFING BOX — NO SPECIAL BOXES NECESSARY.

PORTABLE PRIMARY BATTERY LAMPS.

GUARANTEE TO GIVE 4 C.P. FOR 12 HOURS AT AN EXPENDITURE OF 5 CENTS.

PROMPTNESS. — RELIABILITY.

PENNSYLVANIA ELECTRICAL & RAILWAY SUPPLY CO.
THIRD STREET AND PENN AVENUE.
PITTSBURG, PA.
U.S.A.

SOLAR ENG CO.

ELECTRICAL CATECHISM.

. . . BY . . .

GEO. D. SHEPARDSON, M. E.

Professor of Electrical Engineering in the University of Minnesota.

CONTENTS.

Chapter I.—Static Electricity. II.—Units. III.—Electric Circuits. IV.—Electricity and Heat. V.—Batteries and Electro-chemical Effects. VI.—Electricity and Magnets. VII.—Measuring Instruments. VIII.—Electrical Measurement. IX.—Elementary Motors. X.—Dynamos. XI.—Motors. XII.—Alternating Currents.

Cloth. 1,200 topics, 450 pages, 325 illus. Price, $2.00.

This book puts into concise and accessible form reliable answers to many of the questions that are being asked continually about the theory and applications of electricity. It may be used as an introduction to the more formal treatises, and will furnish the beginner with a fund of general information which will throw much light upon subsequent study of more advanced text-books. The general reader will find it a convenient hand-book of reference for non-technical explanations. The "Socratic" or Question and Answer method of instruction has a great advantage in rendering information concise and accessible and in making progress more definite. This Catechism was undertaken as a serial at the request of the editors of Electrical Industries and its successor, the AMERICAN ELECTRICIAN, and has continued in monthly installments since February, 1895. In compiling it into book form many changes and additions have been introduced. It is believed that the egregious errors which appear in some previous attempts by less able writers have been avoided, and that the information to be secured here may be relied upon as being in accordance with accepted belief and practice, and withal entirely practical in form and application. The value of the work is further enhanced by numerous cross references and a copious index.

Copies of this or any other electrical book published will be sent by mail, postage prepaid, to any address in the world, on receipt of price.

AMERICAN ELECTRICIAN CO.,

Beard Building, New York.

THIRD EDITION—REVISED AND ENLARGED.

American Telephone Practice.

BY KEMPSTER B. MILLER, M.E.

Contents.

CHAPTER I.—History and Principles of the Magneto Telephone. II.—History and Principles of the Battery Transmitter. III.—The Telephone Receiver. IV.—Carbon Transmitters. V.—Induction Coils; Comparative Tests. VI.—Batteries. VII.—Calling Apparatus. VIII.—The Automatic Shunt. IX.—The Hook Switch and Circuits of a Telephone. X.—Commercial and Calling Apparatus. XI.—The Telephone Relay or Repeater. XII.—Self Induction and Capacity. XIII.—Telephone Lines. XIV.—Simple Switchboards for Small Exchanges. XV.—Listening and Ringing Apparatus for Switchboards. XVI.—Self-Restoring Drops. XVII.—Complete Switchboards for Small Exchanges. XVIII.—Lamp Signal Switchboards. XIX.—The Multiple Switchboard. XX.—Transfer Systems. XXI.—Common Battery Systems. XXII.—House Systems. XXIII.—Protective Devices. XXIV.—Distributing Boards. XXV.—Party Lines; Non-selective. XXVI.—Party Lines; "Step-by-Step" Signaling. XXVII.—Party Lines; Strength and Polarity Signaling. XXVII.—Party Lines; Harmonic Signaling. XXIX.—Wire for Telephone Use. XXX.—Pole Line Construction. XXXI.—Telephone Cables. XXXII.—Underground Construction. XXXIII.—Testing. XXXIV.—Storage Batteries. XXXV.—Automatic Telephone Systems. XXXVI.—Specifications for the Installation of Complete Exchanges.

510 large octave pages, 380 Illustrations. Price, $3.00.

This is the first complete treatise on Telephony in the English language. The author was peculiarly qualified for the task, having been an examiner in the U. S. Patent Office in the telephonic class, and subsequently as a telephone engineer had a wide experience in every branch of telephonic work. The text is profusely illustrated by cuts of commercial apparatus and carefully prepared diagrams of circuits. No diagram is given without a full explanation. The apparatus, circuits and methods of the American Bell Telephone Company and of the various independent companies are fully described. The apparatus and methods used in making all of the tests required in commercial telephone work are fully treated.

Copies of this or any other electrical book published will be sent by mail, postage prepaid, to any address in the world, on receipt of price.

AMERICAN ELECTRICIAN CO.,

120 Liberty Street, New York.

Electrical Designs.

Descriptions of Electrical Apparatus of Simple Construction.

CONTENTS.

Chapter I to IX.—Direct-Current Motors of 1/6 h. p. to 3 h. p. X to XII.—Combined Alternating and Direct-Current Machines; 1 kw. to 3 kw. XIII.—Single-Phase Rectifier. XIV.—Universal Alternator. XV.—Single-Phase Induction Motor; ¼ h. p. XVI.—Transformer in Four Sizes. XVII.—Reactive or Choking Coil. XVIII.—Rheostats. XIX.—Voltmeters, Ammeters and Wattmeters. XX.—D'Arsonval Galvanometer. XXI.—Mirror Galvanometer. XXII.—Thomson Astatic Galvanometer. XXIII.—Cheap Wheatstone Bridge. XXIV.—Photometer. XXV.—Storage Battery. XXVI.—Open Arc Lamp. XXVII.—Experimental Nerst Lamp. XXVIII.—Induction Coil. XXIX.—Tesla-Thompson High Frequency Induction Coil. XXX.—Condenser for High Potentials. XXXI.—Wimshurst Influence Machine. XXXII.—Telephone Transmitter and Receiver. XXXIII.—Dry Battery. XXIV.—Commutator Tools.

Cloth. 262 Pages. 289 Illustrations. Price, $2.00.

Each chapter of this book contains a complete design for the piece of apparatus specified by the chapter heading, with full working drawings and explicit instructions which will enable anyone at all accustomed to the use of tools to successfully construct the apparatus. All of the designs have been prepared with a view to reducing as far as possible the shop equipment and amount of labor necessary; in many cases only the simplest of hand tools and easily procured materials are required. The designs of small direct-current motors are particularly useful as they relate to machines of commercial and even higher efficiency, though their construction is of the simplest kind practicable. The sizes included are one-sixth horse-power, drum and ring armature, with windings for 115-volt or battery current; one-fourth horse-power, with windings for 115-volt, 230-volt or battery current; one-half horse-power for 115 or 230-volt circuits; one horse-power, two-pole and four-pole, for 115 or 230-volt circuits; two horse-power, four-pole, and three horse-power, four-pole, both for 115, 230 or 500-volt circuits.

AMERICAN ELECTRICIAN COMPANY,

120 Liberty Street, New York.

SHOP AND ROAD TESTING OF

DYNAMOS AND MOTORS

By Eugene C. Parham, M.E., and John C. Shedd, M.S.

CONTENTS

Chapter I.—Elements of the Dynamo. II.—Elements of the Motor. III.—Ohm's Law. IV.—Measurement of Current. V.—Measurement of Electromotive Force. VI.—Measurement of Resistance. VII.—Measurement of Insulation. VIII.—The Series Machine. IX.—Shunt and Compound Wound Machines. X.—General Tests of Compound Wound Machines. XI.—Compounding. XII.—Miscellaneous Tests. XIII.—Grounds on the Line. XIV.—Motor Testing. XV.—Installation Car Equipment Tests. XVI.—Car Equipment Tests. Appendix.—Copper and Iron Wire Data. Fusing Effects of Currents. Dynamo Testing Record.

Cloth. 626 pages, 211 Illustrations. Price, $2 50

This work is designed to supply the need felt by the college graduate as he steps from the plane of the laboratory and lecture room to the commercial testing floor, and also by station managers and engineers who find the hit-and-miss methods of testing far from satisfactory. The present work has a two-fold object: 1. To give a complete theory of the commercial testing floor, with its multitudinous applications of theory to practice. 2. To meet the demand on the part of operating companies for a manual that shall enable them to do their own repair work and consequent testing. To this end such tests are given as can be undertaken without elaborate or expensive instruments. Part 1 is devoted to fundamental and preliminary conceptions. Part 2 treats of the principles of testing and the use of instruments. Part 3 constitutes the body of the book, and takes up in detail the shop and road tests of dynamos and motors, including heat test, pumping back, compounding, efficiency test, etc. The series, shunt and compound-wound machines are taken up in order, and the circumstances under which they can be operated considered. A chapter on locating faults and grounds will be found of particular service by central station men. Two chapters added to the new edition are devoted to a consideration of the faults most likely to occur to modern street railway equipments, and the shop methods of locating them.

AMERICAN ELECTRICIAN

120 LIBERTY STREET NEW YORK

SENT POST-PAID ON RECEIPT OF PRICE

AMERICAN STEEL & WIRE CO.

AND THE WASHBURN & MOEN DEPARTMENT.

CHICAGO. NEW YORK. SAN FRANCISCO.

...MANUFACTURERS OF...

ELECTRIC WIRES

OF EVERY DESCRIPTION.

Trolley Wire. Round, "Figure 8" or any other special shape.

Weatherproof Feeder Wires. (Solid.)

Magnet Wires. Asbestos and Cotton covered; also single or double Cotton covered. Round, Square or Rectangular.

Insulated Wires. Twisted for Street Railway, Telephone and for general signal service.

W. & M. "Crown" Rubber Wire of exceptionally high grade—for high voltage electric lighting.

"Globe" Rubber Wire for low voltage work.

Our "Crown" and "Globe" wires both conform to the new National Electrical Code Standard.

"Crown" Cables, lead covered for underground service.

Office Wire.

Annunciator Wire.

Car Wire. "Crown" Rubber covered stranded. Made specially for wiring Cars. Cotton or paper wind over conductor to facilitate the making of joint, and preventing the Rubber adhering to strands.

Armature Binding Wires.

Feeder Cables. Bare or insulated, up to 2,500,000 C. M. Capacity.

Lamp Cord.

High Grade W. & M. Double Galvanized Telegraph & Telephone Wires.
Our "EXTRA B. B." "B.B." and "STEEL" are the world's standard in their respective grades.

Our Span Wires, Guard and Guy Wires are most heavily galvanized. Unequaled for efficiency, strength and durability.

A GOLD MEDAL

WAS AWARDED TO THE

AMERICAN ELECTRICIAN

BY THE JURY OF AWARDS AT THE

PAN-AMERICAN EXPOSITION

ELECTRICIANS ENDORSE THE I. C. S.

Becomes Telephone Inspector.

As a result of the International system and the painstaking efforts of the Schools' Instructors, I now hold a position as chief inspector with the Bell Telephone Company. This is the first position I have ever held with any telephone company, and was only secured after passing a rather severe examination, which proves that anyone willing to give up a few of his spare hours to study can fit himself to start in his chosen profession half way up the ladder instead of beginning at the foot. The simplicity of your Instruction Papers makes it possible for anyone to learn. W. W. HOLLENBECK,
Corning, N. Y.

Monthly Salary Advanced $70.00.

When I enrolled I was foreman of the dynamo room for the Cumberland Electric Light and Power Company, of Nashville, Tenn., and I did not think I would ever be able to fill a better position. About a year ago, however, I took up the Course, and a short time ago was offered the chief engineer's position, and satisfactorily fill the place. My salary has been increased from $80.00 per month to $150.00 per month, and the Schools did it for me. What the International Correspondence Schools has done for me it will do for others if they will study.
WM. J. DODGE, Nashville, Tenn.

From Conductor to Chief Electrician.

I owe so much of my success to the Schools that it is with pleasure I state a few of the practical results of my Electric Railways Course. When I commenced my studies, I was a conductor on the Guelph Street Railway. I set to work with a determination and in eight months' time my employers, taking an interest in my progress, made me assistant electrician, with an increase in wages. A few months brought another advance in wages, and I was soon after given my present position as chief electrician, with a further advance. J. H. SWEETMAN,
76 Northumberland Street, Guelph, Ont.

From Motorman to Electrician in Charge.

I have found the instruction furnished by the Schools much more practical than I had anticipated, and I am pleased to recommend it as being thorough and efficient. Although I have not quite completed the Electric Power and Lighting Course, I have been advanced from the position of motorman to that of electrician in charge of the Central Station and lines of the Bonham Electric Light and Power Company. I would not have been able to hold this position had it not been for the instruction received through my Course. I will be pleased to answer any letters regarding the Schools. W. T. SMITH,
Bonham, Texas.

Secured Position as Telephone Inspector.

I have been employed in the telephone and electric-light business for years, and now, through the aid of the Schools, I have secured a position as inspector of one of the exchanges of the New York and New Jersey Telephone Company. I find the educational benefits derived from your Telephony Course of very great service to me in my work. As a reliable source of information pertaining to any part of the electrical business, the Instruction Papers of the Schools are unsurpassed, and are alone well worth the price of the Course. A. W. ZACHARIAS,
216 Greene Avenue, Brooklyn, N. Y.

Doubled His Salary.

When I enrolled in the Electric Power and Lighting Course of the International Correspondence Schools, of Scranton, Pa., I was employed as engineer and dynamo tender for the Walton Electric-Light Company. After I had been studying on my Course for about six months, I showed my Certificates of Progress to the president of another company and was given a position in which I have entire charge of an electric-light plant. My salary has been almost doubled since I enrolled. I believe that I owe my advancement entirely to the International Correspondence Schools and I wish to thank you for the same. WALTER H. DAILEY,
Walton, N. Y.

INEXPERIENCED correspondence schools tell what they *think they can do* for you. The International, the original correspondence school of engineering, refers you to thousands of satisfied students as to what *it has done* for them and *can do for anyone* possessing average intelligence and ambition. On request, we will refer you to students living in your own locality, with whom you may converse or correspond before enrolling. We offer nine electrical courses, i. e., Electrical Engineering, Electrical, Electric Power and Lighting, Electric Lighting, Electric Railways, Electric Car Running, Telephony, Telegraphy, and Wiring and Bellwork.

I. S. C. TEXTBOOKS

make it easy for men already at work to learn by mail: Mechanical, Electrical, Steam, Civil, and Mining Engineering; Shop and Foundry Practice, Mechanical Drawing; Architecture, Plumbing, Sheet Metal Work; Chemistry; Ornamental Design; Lettering; Bookkeeping; Stenography; Teaching; English Branches; Locomotive Running; Electrotherapeutics; German; Spanish; French.

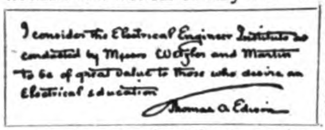
SEND FOR CIRCULAR OF THE COURSE THAT INTERESTS YOU.

INTERNATIONAL CORRESPONDENCE SCHOOLS

Box 1025, SCRANTON, PA., U. S. A.

Can I Become an Electrical Engineer?

YES, you can. We teach **ELECTRICAL ENGINEERING** at your home BY MAIL at a cost within the reach of anyone. **No matter where you live**, if you can read and write, we guarantee to teach you thoroughly. Our institute is **endorsed** by **Thomas A. Edison** and every prominent electrical engineer. We teach also:



I consider the Electrical Engineer Institute as conducted by Messrs Wetzler and Martin to be of great value to those who desire an Electrical education

Thomas A. Edison

Mechanical Engineering, Steam Engineering, Mechanical Drawing, Telephony, Telegraphy, Electric Lighting, Electric Railways, Electric Motorman's Course, Short Electrical Course, Dynamo Tender's Course, Elementary Mathematics, etc., by mail.

Thousands are successful and gaining better positions and salaries studying at home by our correspondence system. Write for our FREE ILLUSTRATED BOOK, "Can I Become an Electrical Engineer?"

THE ELECTRICAL ENGINEER INSTITUTE OF CORRESPONDENCE INSTRUCTION, Dept. G, 240-242 West 23d St., New York.

Jos. Wetzler, M. E., E. E., President.
T. Commerford Martin, Vice-President.

THE BEST COURSES
IN
ELECTRICAL ENGINEERING

For Home Study are those offered by

THE CONSOLIDATED SCHOOLS

EMBRACING

The United Correspondence Schools,
The Institute for Home Study of Engineering,
and The Correspondence School of Technology,

156 FIFTH AVENUE, NEW YORK

Write for Catalogue No. 8, Free Sample Pages of Lessons, Drawing Plate and Booklet of Letters from Students all over the world. Low Fees. All can study without losing time from work. Courses in

ELECTRICAL ENGINEERING, STATIONS, LIGHTING, RAILWAYS, TELEPHONE and TELEGRAPH.
Also Steam and Mechanical Engineering, Mechanical Drawing and others.

SPECIAL DISCOUNTS NOW

MONON ROUTE
CHICAGO, INDIANAPOLIS & LOUISVILLE RAILWAY

THE DIRECT LINE

BETWEEN

Chicago, Indianapolis, Cincinnati, Lafayette, Louisville,

AND ALL POINTS

SOUTH.

Through Sleepers to Washington and Baltimore.

CITY TICKET OFFICE, 232 Clark St.
FRANK J. REED, General Passenger Agent.
CHICAGO.

MORE THAN I EXPECTED

Said the late Philip D. Armour: "We can't help the past, but we can look out for the future."

THE AMERICAN SCHOOL OF CORRESPONDENCE offers a wonderful opportunity to an ambitious man for overcoming the defects of early education and paving the way to a prosperous future. It offers courses by correspondence in

Mechanical Locomotive
Stationary Textile
Electrical Marine

ENGINEERING

Heating, Ventilation and Plumbing; Mechanical Drawing,

Including Isometric, Perspective and Descriptive Geometry,

under instructors trained and teaching in the great technical schools for which Boston is famous.

Ambitious men who cannot attend a regular technical school because they cannot afford the time or money, or because they feel too old, can in this way obtain an opportunity to undertake studies which they have long felt would be of advantage to them in their daily work, under the direction of thoroughly competent instructors. A scholarship cannot be forfeited; a student can, therefore, suit his studies to his own convenience. Tuition may be paid in small monthly installments.

The School refers by permission to college and technical school graduates, and many officers of large manufacturing institutions, who are among its most enthusiastic students.

The advantages offered by a school located in a great educational and manufacturing centre like Boston are self-evident to every intelligent man.

SPECIAL PREMIUM OFFER.

For the purpose of securing a large number of new students in the early winter months, we will for a limited time give with each full engineering course our new

Reference Library of Engineering Practice.

This handsome set of books is bound in half morocco, and consists of over two thousand pages from our most valuable lesson papers in the Electrical, Mechanical and Steam Engineering courses, forming a unique and extremely valuable technical library.

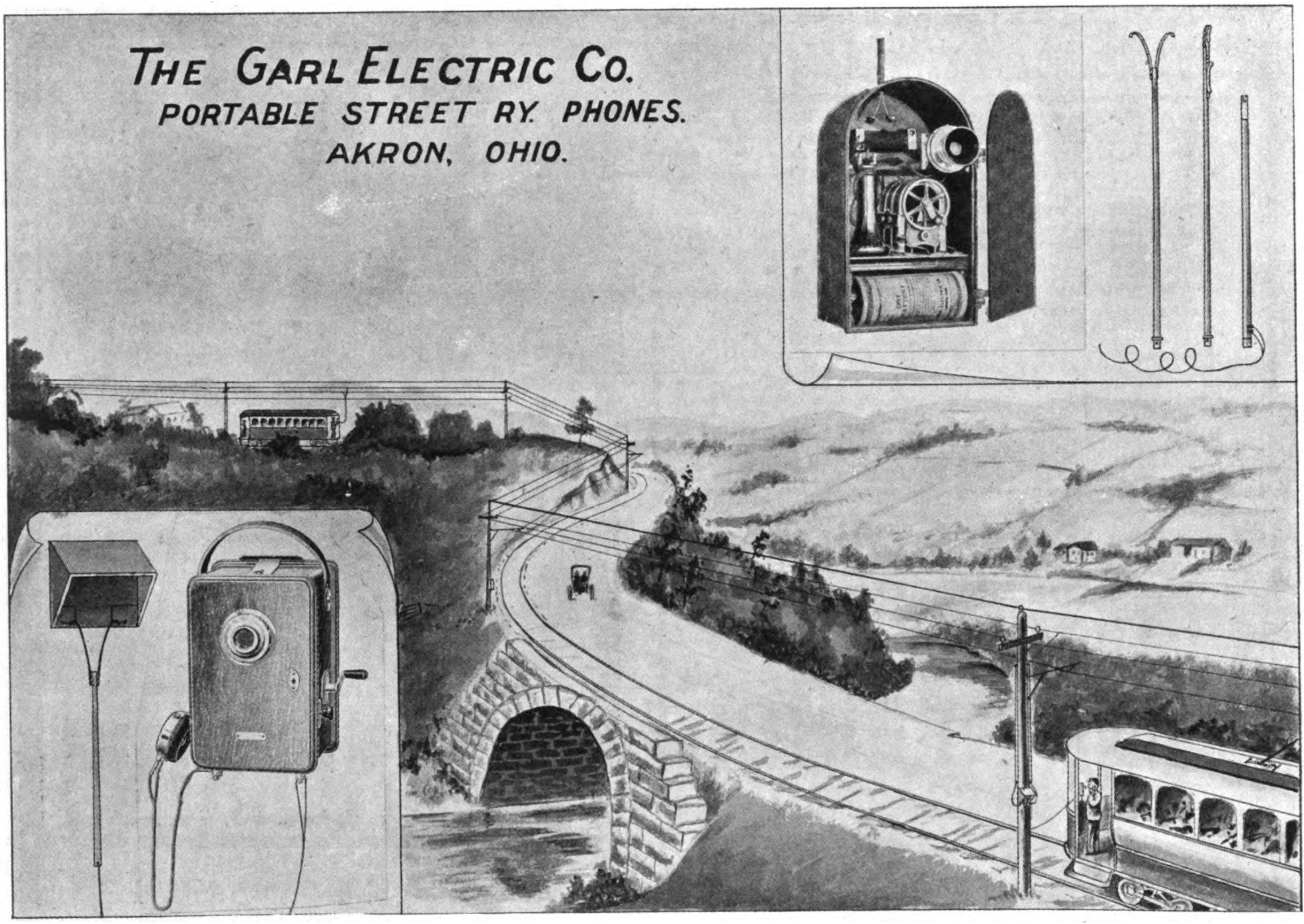
Full description, and Hand-book describing courses, methods and terms, may be had on application.

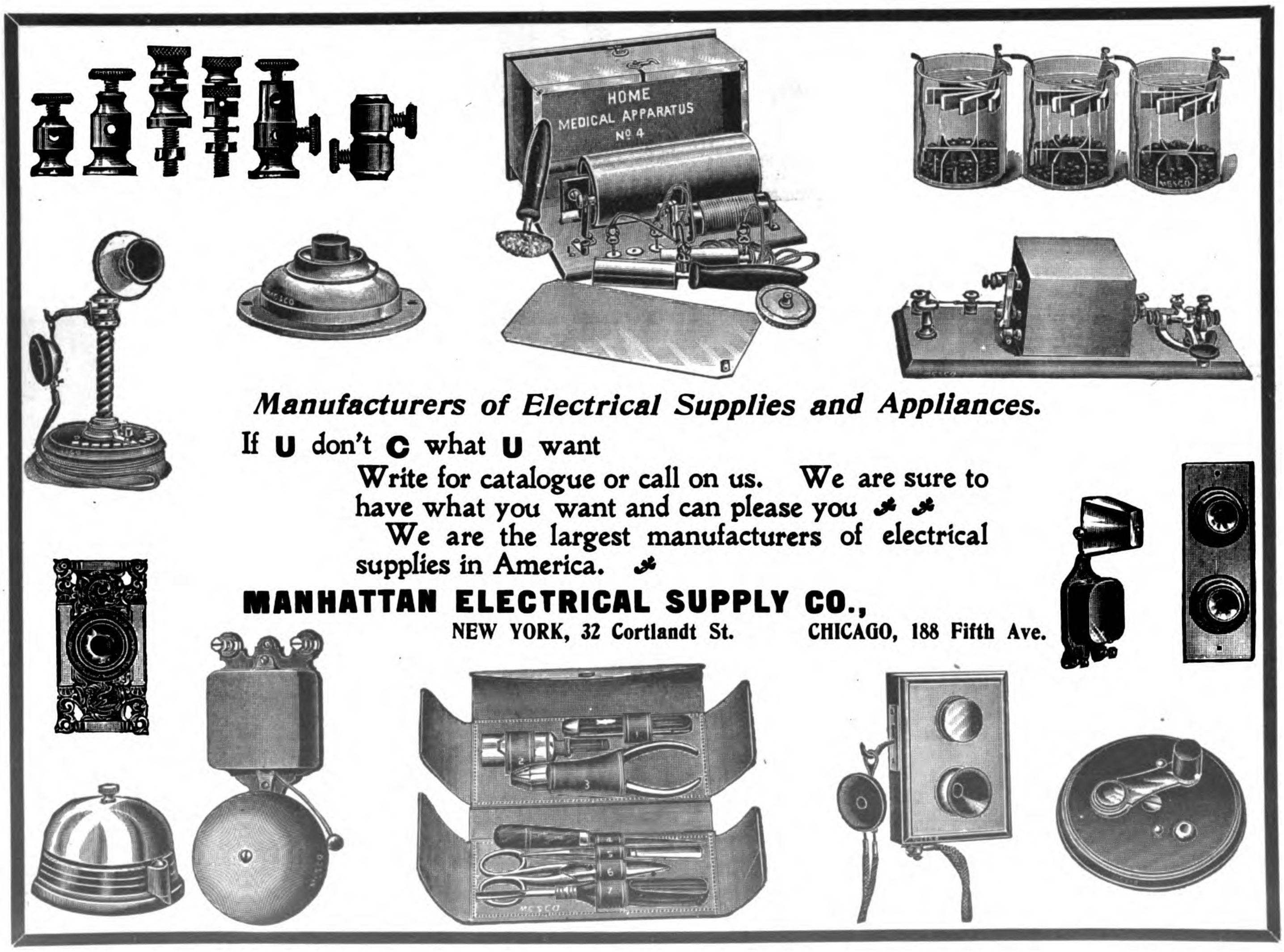
AMERICAN SCHOOL OF CORRESPONDENCE

(Chartered by the Commonwealth of Massachusetts)

BOSTON, MASS., U. S. A.

Mention American Electrician.


THE GARL ELECTRIC Co.
PORTABLE STREET RY. PHONES.
AKRON, OHIO.


Manufacturers of Electrical Supplies and Appliances.

If **U** don't **C** what **U** want

Write for catalogue or call on us. We are sure to have what you want and can please you ☘ ☘

We are the largest manufacturers of electrical supplies in America. ☘

MANHATTAN ELECTRICAL SUPPLY CO.,

NEW YORK, 32 Cortlandt St. CHICAGO, 188 Fifth Ave.

GOLD MEDAL

Extract from Report of Pan-American
Jury of Awards, Division X, Electricity

STROMBERG-CARLSON
TELEPHONE MFG. CO.

CHICAGO.

A Gold Medal for Telephone Exhibit and Service

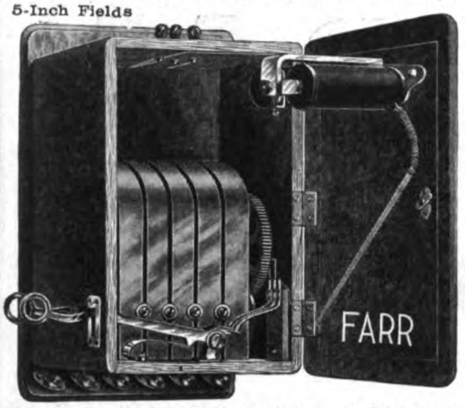
Independent Telephone Service already demonstrated in this city.

The question of telephone service with equipment of independent manufacture has been well demonstrated at the Pan-American Exposition. For telephone service between the officials and various buildings throughout the grounds it was decided, after months of investigation by the officers, to adopt an independent system. The plant was put in operation before the opening of the fair and has given the best possible service continuously without interruption, and is said to be far superior to the city exchange. The manufacturers of the system, the Stromberg-Carlson Telephone Mfg. Co., Chicago, it is said, are manufacturing more than 100,000 instruments annually for large and small public exchanges.

Gold Medal for Exhibit of a Model Telephone Exchange
and for its Service on Pan-American Grounds.

OUR BRIDGING MAGNET BELL
50,000 and 100,000 OHM RESISTANCE Guaranteed

5-Inch Fields



We make 15 different styles of Telephones for bridging and exchange use.

We keep a full line of

SUPPLIES
BRACKETS
INSULATORS
KNOBS, PINS
CROSS ARMS
and WIRES

SEND FOR NEW CATALOGUE No. 15

FARR TELEPHONE & CONSTRUCTION SUPPLY CO. Chicago
——118-120 W. Jackson Boulevard——

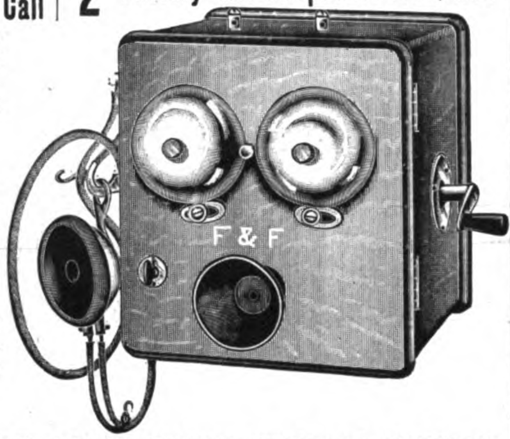
---

2 FOR $7.50 Generator Call | 2 Battery Call Telephones for $4.50

GENERATOR TELEPHONE
Good for 3 miles.

BATTERY TELEPHONE
Good for 600 feet Metallic Circuit.

Sent C. O. D. by express if $1.00 is sent with order.



ADDRESS....
FARR & FARR, 120 W. Jackson Boulevard, CHICAGO

Spark Coils

For Gas Lighting and Gas Engine purposes

STANDARD COILS ALWAYS ON HAND.
SPECIAL COILS MADE ON SHORT NOTICE.

Our Waterproof Gas Engine Coil is just the thing for damp climates

WRITE FOR PRICES

VARLEY DUPLEX MAGNET CO.,

82 Lake Street, CHICAGO. | Phillipsdale, R. I.

Everything in TELEPHONES

from a Hotel System to **Central Battery** Lamp Signal Multiple Switchboards.

EVERYTHING WE MAKE IS GOOD.

CENTURY TELEPHONE CONSTRUCTION CO.
CLEVELAND, OHIO

USE D. & W. FUSES

D. & W. FUSE CO., Providence, R. I.

New Excelsior Dry Battery

Rou nd Carbon.

EFFICIENT, UNIFORM, DURABLE, ABSOLUTELY RELIABLE.

Sent on approval to any responsible concern.
ALL SHAPES AND SIZES.

NEW EXCELSIOR DRY DATTERY MANUFACTORY
108 Greenwich Street, New York

PROTECTORATE

Electric Light Central Stations
Telephone Central Stations

Use Protectorate and prevent the burning out of magnets and spools. Absolutely *IMPERVIOUS* to *HEAT* and *MOISTURE.* Put up in 5-pound cans. Made only by us.

"PROTECTORATE" CO.
183 TO 187 DEARBORN ST., CHICAGO

The Telephone Company of America, Long Distance, Central Energy System.

The only up-to-date one hundred per cent. system, full patent protection.
The only first class system at a cost admitting of no competition.
The only system that can be supplied to the public at two cents per call.
The only system that can be installed in every house, office, mill, shop or other place of business, at two cents per call and insure share-holders a handsome profit on their investment.

The aim of the Telephone Company of America is to place a telephone in every house and place of business and to limit the charge for its use at two cents per call, the same as for sending a letter.

Installation on this plan admits of no competition. By this system the telephone service will be increased to twenty times its present volume; its value to investors will be many times greater than that of any other system, while the cost of service to the public will be only two cents per call, or one-third the lowest present rates.

The central office and station telephone apparatus are of the highest excellence in quality and appearance.

For particulars, write or call at the office of

THE TELEPHONE COMPANY OF AMERICA,
719-721 13th Street, N. W., WASHINGTON, D. C.

KELLOGG

SWITCHBOARD AND SUPPLY CO.

MANUFACTURERS OF

High-Class Telephone Equipments.

AWARDED

GOLD MEDAL

PAN-AMERICAN
EXPOSITION
1901

HIGHEST AWARD FOR

Telephone Systems and Apparatus.

Telephone Switchboards
for Small Exchanges.

Central Energy
or Magneto.

331 SOUTH GREEN STREET,
CHICAGO.

THE NORTH SUPERVISORY SYSTEM.

For all SIZES of EXCHANGES.

It Reduces Number of Operators.
Increases Speed of Connections.
Saves Time of Subscriber.
Has no bad Clicks in the Ear; and
Has Smallest Consumption of Battery.

Pays Dividends.

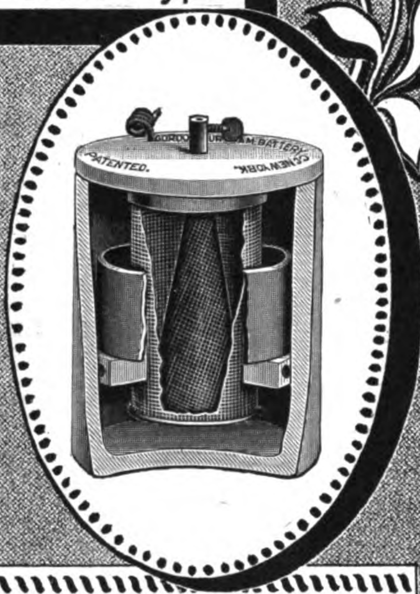
Write for Particulars.

The North Electric Co.,
165-175 Frankfort St., Cleveland, Ohio.
Chicago—1511 Monadnock Block.

WE manufacture the regular designs as well as a number of SPECIALTIES.

LET US SEND YOU A CATALOGUE. : : :

The Lambert-Schmidt Telephone Mfg. Co.
325 Broadway, New York City



THE GORDON
No. 1 Cell-Banks Type.

A Superior Generator of Energy.

THE GORDON CELL
Bases its chief claims of Superiority on Expert Testimony and Practical Demonstration.

THE GORDON BATTERY CO.
13 and 15 LAIGHT ST., NEW YORK.
Western Agent: E. M. DEEMS, 358 Dearborn St. Chicago

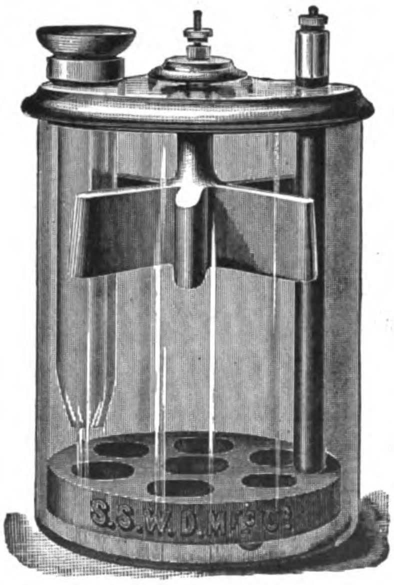
THE PARTZ ACID GRAVITY BATTERY FOR ALL OPEN CIRCUIT WORK.

The Highest Voltage, Strongest and Longest Lasting Battery in the World.
Awarded Medal and Diploma at Columbian World's Fair after Competitive Tests for *Heavy Electric Bell Work, Annunciators, Open Circuit Electric Signals, Electric Clocks, Watchmen's Clocks, Long Distance and continuously used Telephones, etc.*

SEND FOR CATALOGUE.

The attention of Architects, Contractors, Builders, Dealers in Electrical Supplies, Telephone Companies, etc., is called to this Battery.

Many of the large hotels throughout the country are now replacing unsatisfactory batteries with the *PARTZ ACID GRAVITY BATTERY.*



Partz Acid Gravity Battery No. 4.
Jar, 6 in. x 8 in.
E. M. F. 1.9 to 2 Volts.
Current on Short Circuit, 1 to 2 Amperes.
PRICE $1.50 PER CELL.

PARTZ SULPHO-CHROMIC SALT
FOR USE IN
PARTZ ACID GRAVITY BATTERIES
AND FOR MAKING
ELECTROPOION FLUID.

ECONOMY—SAFETY—EFFICIENCY.

SULPHO-CHROMIC SALT, when dissolved in water, makes a standard electropoion fluid without the necessity of handling liquid acids, having practically the same amount of stored energy as an equal quantity of fluid made in the ordinary ways, giving with a zinc carbon element an E. M. F. of 1.9 to 2 volts and an ampere-hour capacity of *about the same.*

We especially call the attention of battery users to this substance as affording the best, cheapest, and most convenient method of making electropoion fluid for medical batteries, Grenet cells, Bunsen batteries for lecture tables, experimental work, etc., and motor batteries.

SULPHO-CHROMIC SALT is put up in air-tight jars, with screw-lid, each jar containing two pounds. As the Salt is hygroscopic, it must be guarded against moisture.

PRICE PER JAR, 2 LBS., $0.75.

Manufactured and For Sale by

THE S. S. WHITE DENTAL MFG. CO.,

BRANCHES:
New York: 5, 7 and 9 Union Square, West.
Windsor Arcade, 5th Ave. and 47th St.
Boston: 110 and 112 Boylston St.
Chicago: Randolph St., cor. Wabash Ave.
Brooklyn: 446 and 448 Fulton St.

Chestnut Street, cor. Twelfth Street,
PHILADELPHIA, PA.

BRANCHES:
Atlanta: Prudential Building.
Rochester: 513-519 Chamber of Com. Bldg.
Berlin (Ger.): Lindenstrasse, 37.
Buenos Aires (R. A.): Calle Victoria, 750.
St. Petersburg (Russia): Gr. Morskaja, 21.
Toronto (Can.): 110 and 112 Victoria St.

GENERATORS CONDUITS
SPRAGUE
ELECTRIC COMPANY.
MOTORS · FANS MULTIPLE UNIT

LIGHT

GENERATORS CONDUITS
SPRAGUE
ELECTRIC COMPANY.
MOTORS · FANS MULTIPLE UNIT

UNEQUALED SERVICE

SPLIT-POLE GENERATORS

HIGHEST TYPE OF DYNAMO CONSTRUCTION

NON-SPARKING HIGH EFFICIENCY

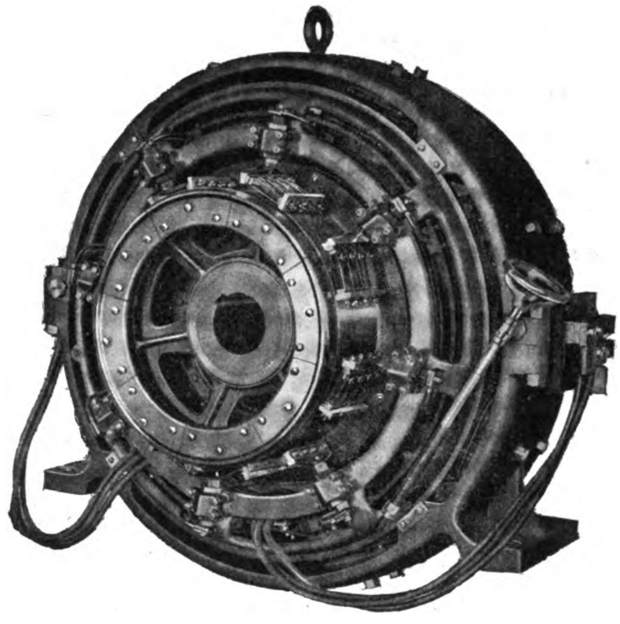
Remarkable
Durability

Best
Possible
Commercial
Value

Railway
Power Plants

Central
Stations

Isolated
Plants



ENGINE TYPE SPLIT POLE GENERATOR. 400 K.W.

The split pole generators are made in sizes from 25 k.w. to 1,000 k.w. Their unusual advantages are fully described in Catalogue No. 1005, which will be sent free upon application. Correspondence cordially invited.

SPRAGUE ELECTRIC COMPANY

General Offices: 527-531 West 34th Street, New York

BRANCH OFFICES:

CHICAGO
Fisher Building

BOSTON
275 Devonshire Street

ST. LOUIS
Security Building

BALTIMORE
Maryland Trust Building

GENERATORS CONDUITS
SPRAGUE
ELECTRIC COMPANY.
MOTORS · FANS MULTIPLE UNIT

POWER

GENERATORS CONDUITS
SPRAGUE
ELECTRIC COMPANY.
MOTORS · FANS MULTIPLE UNIT

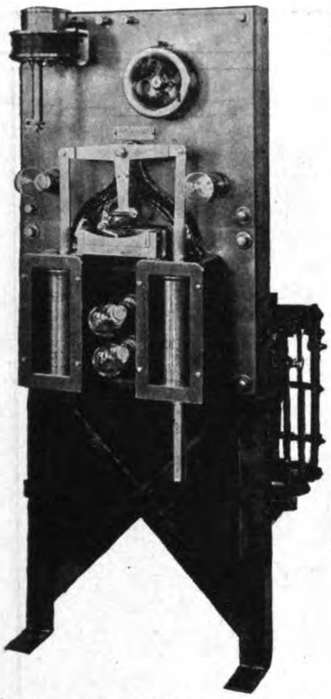
W. H. C. VOLTAGE REGULATORS

THE LATEST IMPROVED

. . . OF . . .

W. H. CHAPMAN

Patented May 1st, 1900



Independent Switchboard Type.

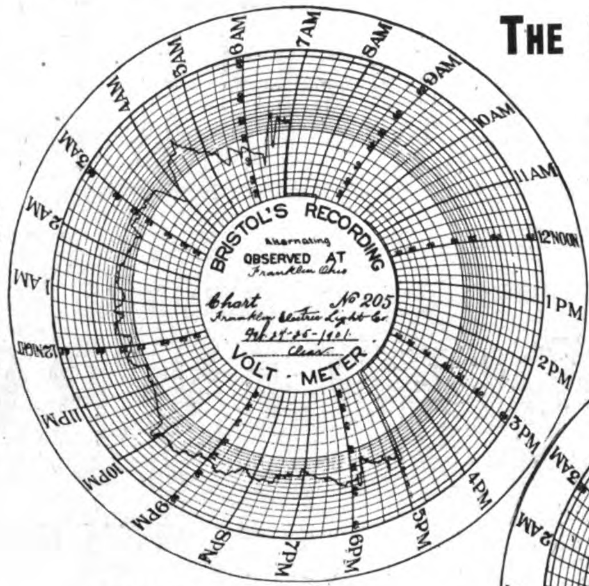


Chart Without Regulator.

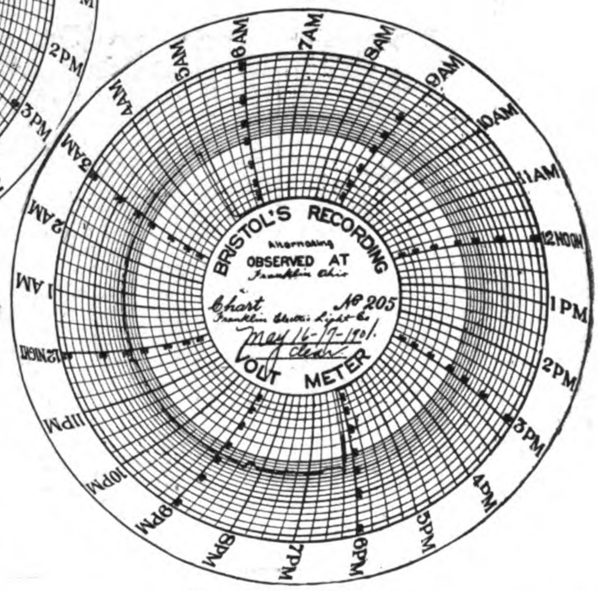


Chart With Regulator.

Charts taken from an Alternator with 20 per cent. speed variation.

PORTLAND COMPANY Inc. 1846

Write for Circulars and Testimonials

PORTLAND, MAINE

W. H. Chapman
Electrician

WESTON Standard Illuminated Dial Station Instruments

Weston "Potential Indicator"
No 17
Made By
Weston Electrical Instrument Co.
Newark N.J. U.S.A.

THESE instruments are based upon the same general principle, and are just as accurate as our regular Standard Portable Direct Current Voltmeters and Ammeters, but are much larger and the working parts are inclosed in a neatly designed, dustproof cast-iron case which effectively shields the instruments from disturbing influences of external magnetic fields.

WESTON ELECTRICAL INSTRUMENT CO.,
WAVERLY PARK,
ESSEX COUNTY, N. J.

Berlin: European Weston Electrical Instrument Co., Ritterstrasse 88.
London; Elliott Bros., 101 St. Martins Lane.
Mention American Electrician.

Full Size.

Test Your Batteries

WITH AN

Eldredge Battery Voltmeter

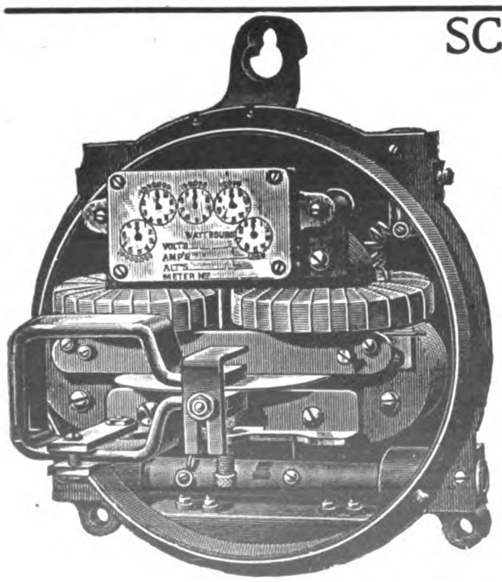
For Testing Primary and Storage Batteries. 0 to 6 Volts.

DEAD BEAT . . .

The only low-price pocket instrument indicating in volts. Connecting posts have non-removable nuts. Light weight and neat in appearance.

Eldredge Electric Mfg. Co.

Springfield, Mass., U. S. A.



SCHEEFFER RECORDING WATT-METER

......FOR......

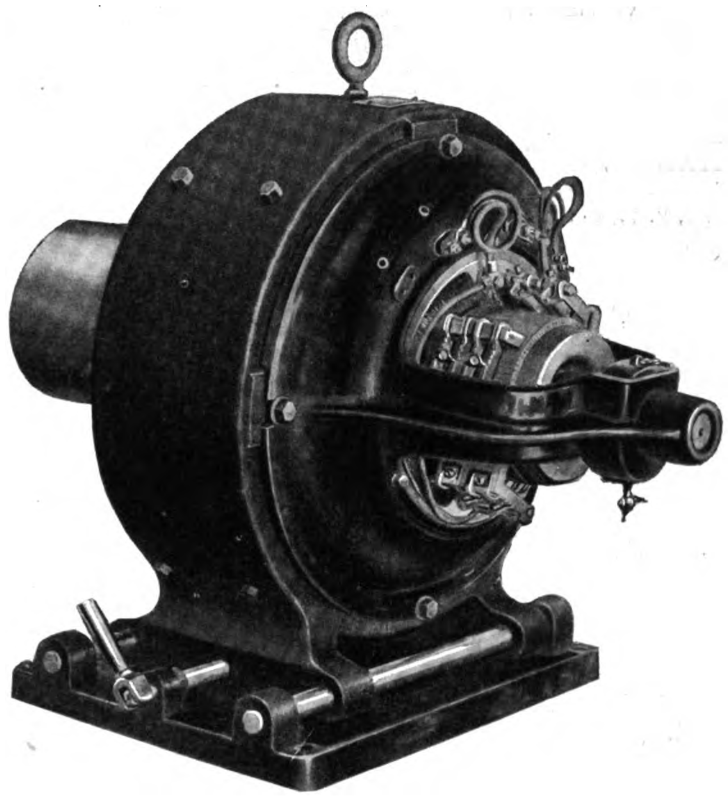
Alternating Currents.
Round Pattern Type E.

A True Watt-Meter for Inductive and Non-Inductive Loads of Any Power Factor.

Correct Record. Highly Sensitive.
Highly Economical. Permanent.
Improved Ball Bearings.

DIAMOND METER CO.,

Peoria, Ill., U. S. A.



IN OUR

PROTECTED TYPE

you find a machine conservatively rated, of beautiful lines, of artistic design, of correct electrical and mechanical balance, and workmanship in accordance with best modern factory practice.

Confining ourselves to the making of motors from 1-16 to 10 H. P. and dynamos from ¼ to 10 K. W., with 30,000 sq. ft. of floor space, and with the best materials and processes coupled with the production on the most economical basis, we are enabled to *quote very attractive prices*, especially to users of a large number of these sizes.

All voltages for direct current.

THE ROBBINS & MYERS CO.

Main Office and Works,
Springfield, Ohio.

Eastern Sales Office,
136 Liberty St., New York City.

CHAPMAN AUTOMATIC VOLTAGE REGULATOR IMPROVED.

Sent on 30 days' trial FREE.
They increase the capacity of Generators 20 per cent.
Reduce lamp renewals.

WRITE FOR PARTICULARS.

Belknap Motor Co.
Branches, all principal cities

Home Office and Factory,
Portland, Maine, U. S. A.

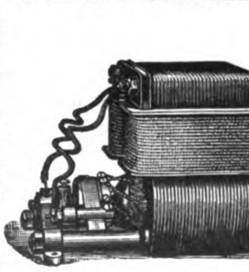
STUDENTS' . . .
VOLT-AMMETER, $5.00. . .

JEWEL BEARING ALUMINUM CASE

List of colleges and schools using it for laboratory work mailed on application.

Each instrument carefully calibrated and provided with hand-made scale.

L. E. KNOTT APPARATUS CO.
16 ASHBURTON PLACE, BOSTON.



ROTH Dynamos and Motors

MOTORS for all purposes where power is used. For belt or direct connection to machinery. Slow or moderate speeds

DYNAMOS for Private Lighting Plants. Absolutely first-class. Fully guaranteed.

ROTH BROS. & CO., Mfrs.,
86-90 W. Jackson St., Chicago, Ill.

Rotary Meter
FOR
Direct Current

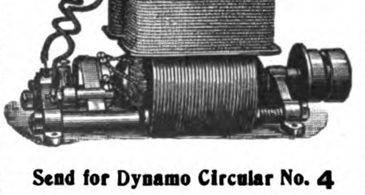
MOST ACCURATE.
MOST DURABLE.
NO COMMUTATOR.
NO JEWEL.

Many Other Advantages.

WRITE FOR THEM

OFFICES:
OMAHA BUILDING.

The Franklin Model Dynamo



10 volts, 5 amperes. Shunt or series winding. We furnish all materials, punchings, etc., in sets with blue prints and directions. To the electrical student, amateur or ingenious boy these machines are of the greatest interest as they furnish practical experience in construction and winding.

Send for Dynamo Circular No. 4

Parsell & Weed,
129-131 West 31st St. New York City.

YOUNGLOVE & GERE

Improved Dynamo Brushes.

Nothing but the best material used. No sewing or solder required, as each brush is provided with a patent adjustable shield.

MANUFACTURED BY
U. S. ELECTRIC CONTRACTING CO.,
SYRACUSE, N. Y., U. S. A.

All Styles and Sizes.

The Best on the Market.

Give Them a Trial.

All Brushes Guaranteed.

Write for Prices.

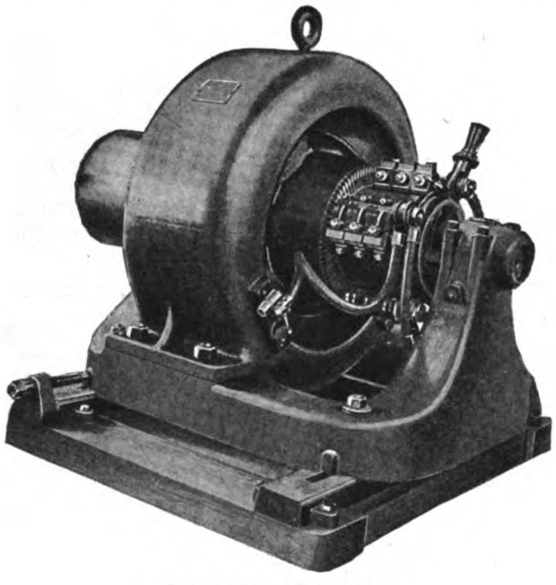


Fig. 39, D Type.

HAVE you investigated the many merits and valuable features of our product

?

WRITE FOR BULLETINS.

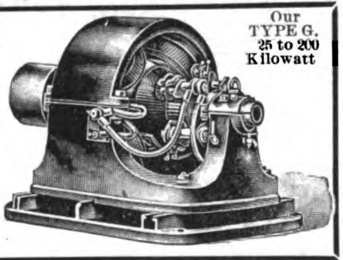
CROCKER-WHEELER CO.,

Manufacturers and Electrical Engineers,

Main Office and Works: AMPERE, N. J., U. S. A.

HIGH GRADE, SLOW SPEED

Dynamos and Motors.

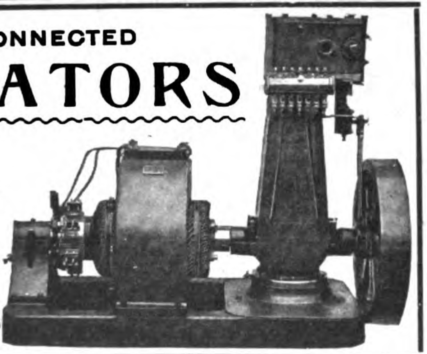


THE NEW ENGLAND MOTOR CO.
LOWELL, MASS.

DIRECT-CONNECTED

GENERATORS

From 12 to 500 Lights.
EFFICIENT, ECONOMICAL, RELIABLE, COMPACT.
Before buying get our prices.
We can save you money.
Send for new Catalog



ENGBERG'S
Electrical and Mechanical Works,
ST. JOSEPH, MICH.

SINGLE PHASE

POWER MOTORS.

1-20th to 2 1-2 Horse Power.

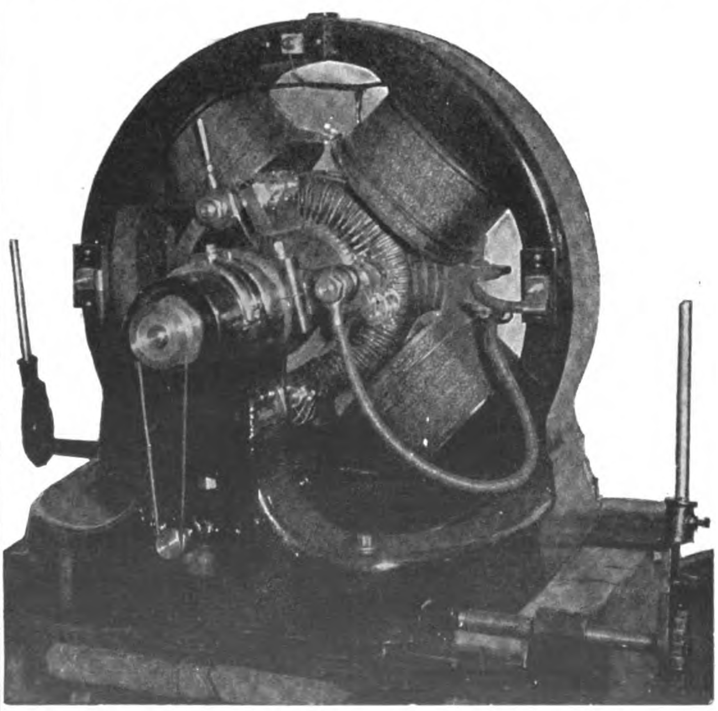
SEND FOR BULLETINS.

The Emerson Electric Mfg. Co.
714-716-718 St. Charles St., ST. LOUIS, MO.
Eastern Office and Warehouse: 136 Liberty St., NEW YORK CITY

SAVE YOUR COMMUTATORS
by using THE K. & W. DYNAMO BRUSH and COMMUTATOR COMPOUND.
The Cheapest and Best on the Market.
THE K. & W. COMPANY, Pittsfield, Mass.
Manufacturers of Dynamos, Brushes, Commutator Compound and Arc Light Hanger Boards. Samples of Compound FREE. Agents wanted.

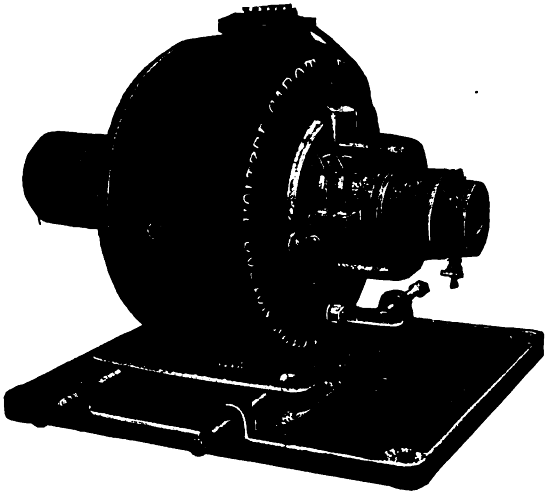
BIPOLAR AND MULTIPOLAR

Motors and Generators



Fully Guaranteed. Prices Low. Write for Catalog B.

BARTZ, EVANS & WYGANT.
HORNELLSVILLE, N. Y.



UNIVERSAL

Enclosed Motors and Dynamos

TYPE "E." SIZES 1-6 to 10 H. P.

May be mounted on wall, floor or ceiling, and are arranged for either gearing or direct connection.

These machines embody the latest and most improved principles of design, the very best material and most careful workmanship.

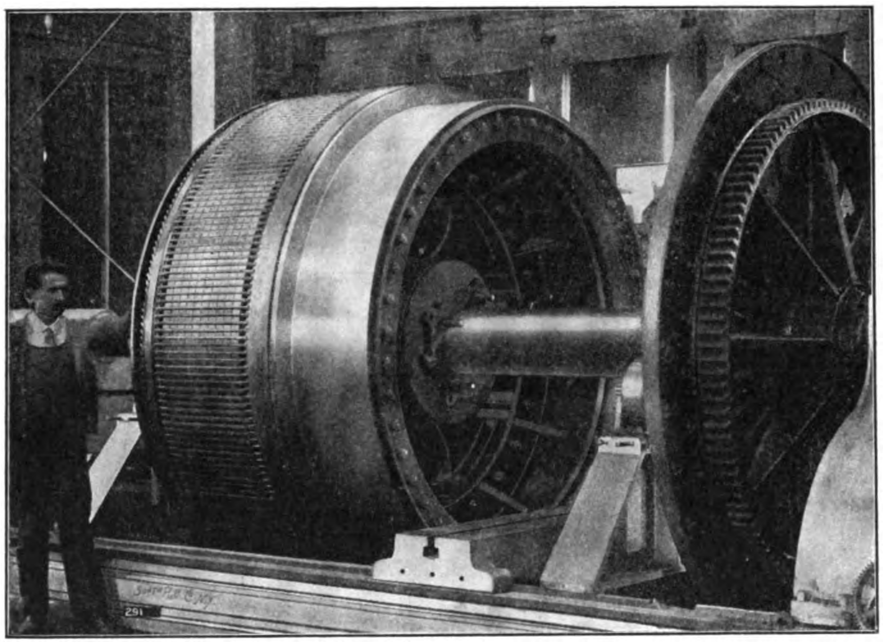
They are efficient, cool running and sparkless in operation.

Bulletin No. 126 Tells All About Them.
Send for a Copy.

THE HOLTZER-CABOT ELECTRIC CO.,
Boston (Brookline), Mass.
Chicago Office, 307 Dearborn Street.

A THOUSAND KILOWATT

BULLOCK RAILWAY GENERATOR ARMATURE.



COULD YOU ASK FOR ANY BETTER DESIGN THAN THIS?

SALES ORGANIZATION:

BULLOCK ELECTRIC MFG. CO. **WAGNER ELECTRIC MFG. CO.**

323 CINCINNATI U. S. A. ST. LOUIS

Dynamos and Motors

From 5 H. P. Up. **For Lighting and Power.**

Combining in their construction the very best material, most skilled workmanship, careful inspection and testing, thereby insuring the . . . . . .

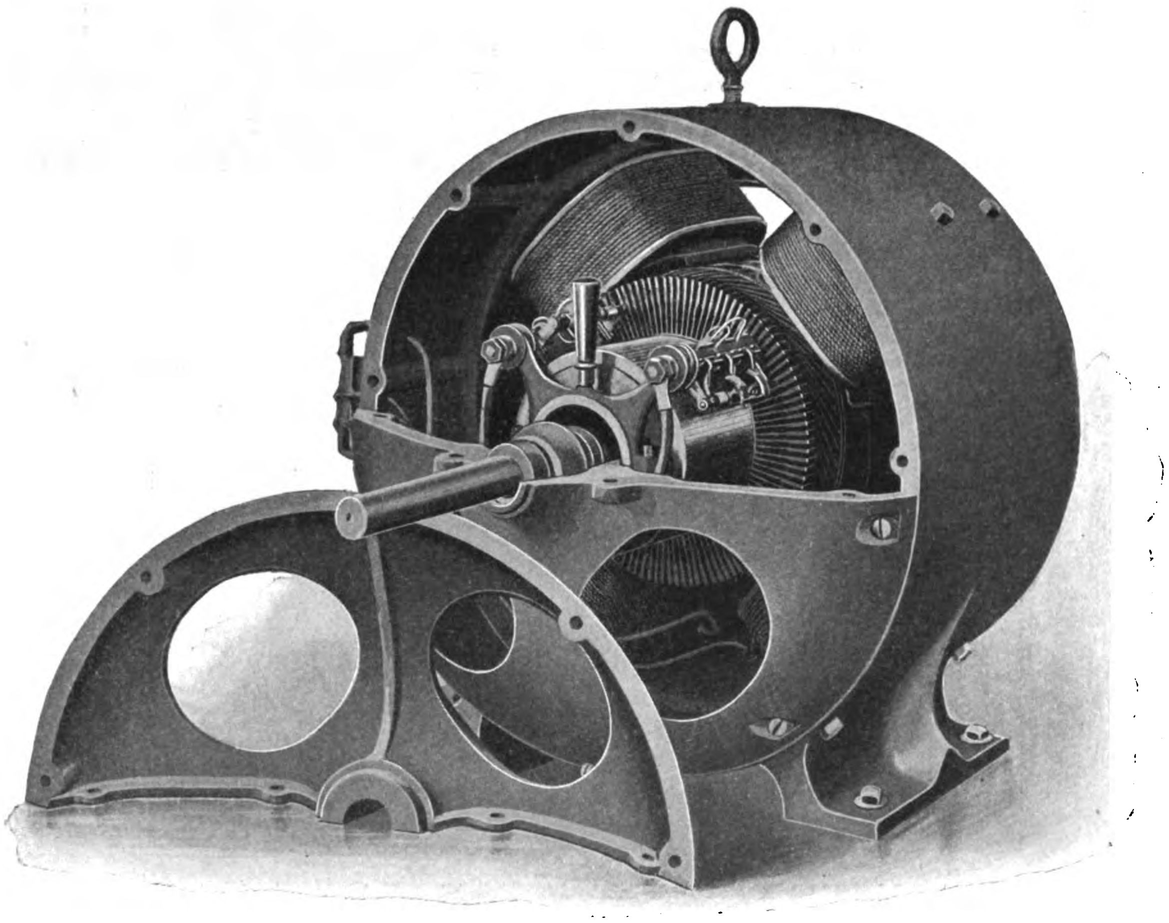
HIGHEST EFFICIENCY ATTAINABLE.

Write for Circulars and Prices.

RELIANCE ELECTRIC COMPANY,
206-222 South Water Street, MILWAUKEE, WIS.

THRESHER GENERATORS AND MOTORS

Are Receiving the Highest Testimonials for Electric Railway, Lighting and Power Transmission.



MOTOR SHOWING DETAILS OF CONSTRUCTION.

The Thresher Type "E" Motor, either wholly or partially enclosed, offers special adaptability for all requirements of power transmission.

MANUFACTURED BY

The Thresher Electric Co.

Main Office and Works:
DAYTON, OHIO, U. S. A.

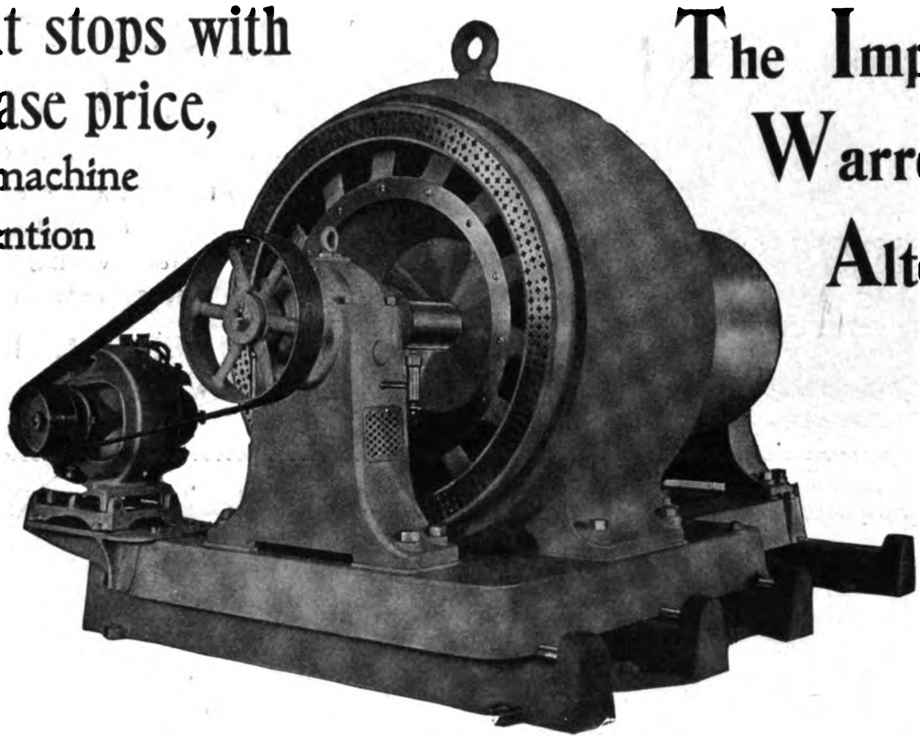
New York Office:
120 LIBERTY STREET

Investment stops with the purchase price,
because the machine needs no attention and requires no repairs.

NO MOVING WIRE.
NO COMMUTATOR.
NO BRUSHES.

The Improved Warren Alternator

"The Perfection of Dynamo Building."



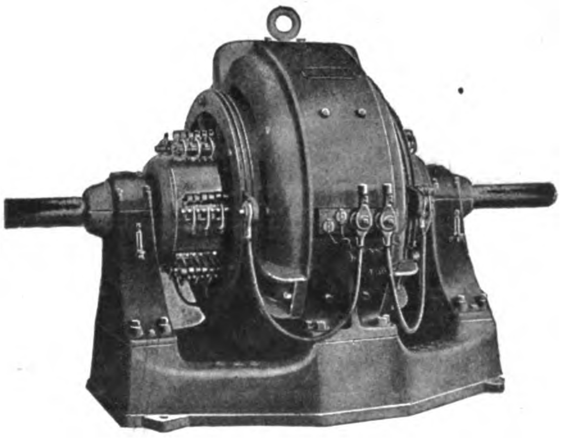
250 KW. WARREN ALTERNATOR.

WARREN ELECTRIC MANUFACTURING COMPANY, SANDUSKY, OHIO, U. S. A.

Rumsey Electrical Mfgrs. Co., 1217 Filbert St., Philadelphia, Pa.; H. B. Coho, 149 Broadway, New York; J. H. Gates & Co., 13-15 Monadnock Blk., Chicago; Thos. Muir & Son, Detroit, Mich.; Iron City Engineering Co., 410 Penn Ave., Pittsburg, Pa.; Western Electrical Supply Co., St. Louis, Mo.; C. W. Hobson Waco, Texas; Kilbourne & Clark Co., 816-817 Second Ave., Seattle, Washington, Pacific Coast Agents; Smith-Courtney Co., Richmond, Va.; H. B. Warren Sandy Hill, N. Y., agent for northern and western New York and the New England States; Johnson Law Co., Jacksonville, Fla., agents for Florida.

In . . . . **The C & C Series-Parallel System of Control**

FOR DOUBLE COMMUTATOR MOTORS



150 H. P. C & C Type "M. P." Double-Commutator Motor.

May be found THE HAPPY SOLUTION OF MANY A TOUGH PROBLEM in ELECTRIC POWER APPLICATION where the requisites are

Highest Attainable Efficiency
Close Regulation
Wide Range of Speed Variation
Heavy Starting Torque
Ability to Stop Motor Quickly
from many locations.

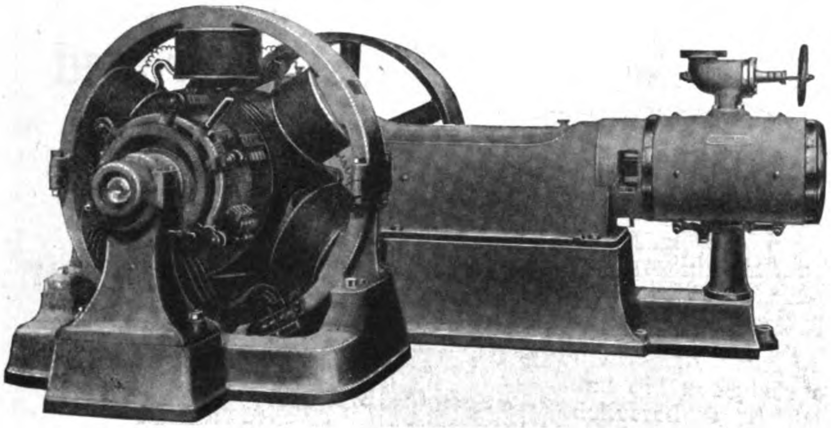
SIMPLICITY and ENTIRELY AUTOMATIC CONTROL through a SINGLE LEVER.

OUR system merits a thorough investigation by those interested, to whom our new "Series-Parallel" Bulletin No. 138 will be sent on receipt of business card.

THE C & C ELECTRIC COMPANY, 143 Liberty St., NEW YORK.

WORKS: GARWOOD, N. J.
C. R. HEAP, 47 Victoria St., Westminster, London, England.

Branches { 45 N. 7th St., Philadelphia; 19 High St., Boston; Monadnock Bldg., Chicago.



Commercial Generators

HAVE

STEEL FRAMES with ROUND CORES and POLE SHOES.

This is ONE reason why they are more efficient than others.

See Circular No. 320 for other features.

COMMERCIAL ELECTRIC CO.,

210 W. Merrill Street, INDIANAPOLIS, IND.

1200 Fisher Bldg., CHICAGO.

E. G. BERNARD CO.

MANUFACTURERS OF

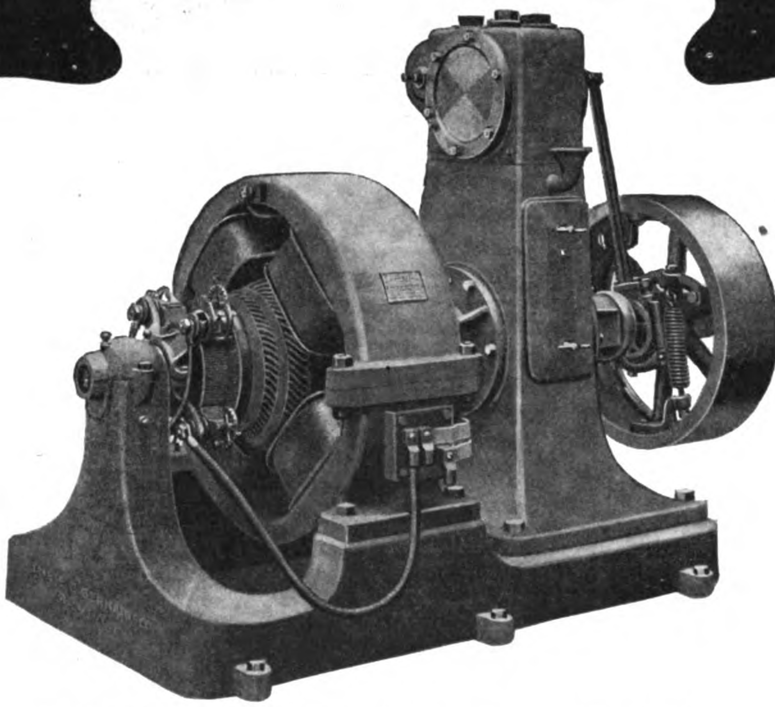
GENERATORS

AND

MOTORS

TROY,

N. Y.



7½ K. W. Type B.—Bernard Generator Direct Connected to Vertical Engine.

AKRON GENERATORS AND MOTORS.

MANUFACTURERS OF

Direct Current Electrical Apparatus

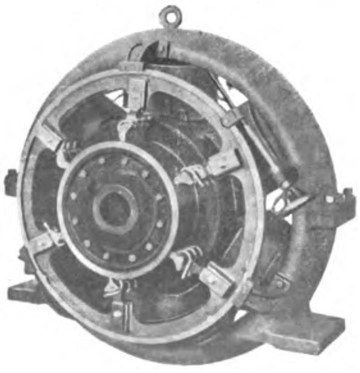
GENERATORS—Slow and Moderate Speed; Direct-connected and Belted Types.

MOTORS—Slow and Moderate Speed; Direct-connected and Belted Types; Open and Enclosed, suitable for Wall and Ceiling Attachment.

SEND FOR BULLETINS AND CATALOGUE.

New York Branch:
MAC KAY ENGINEERING Co.,
149 Broadway.

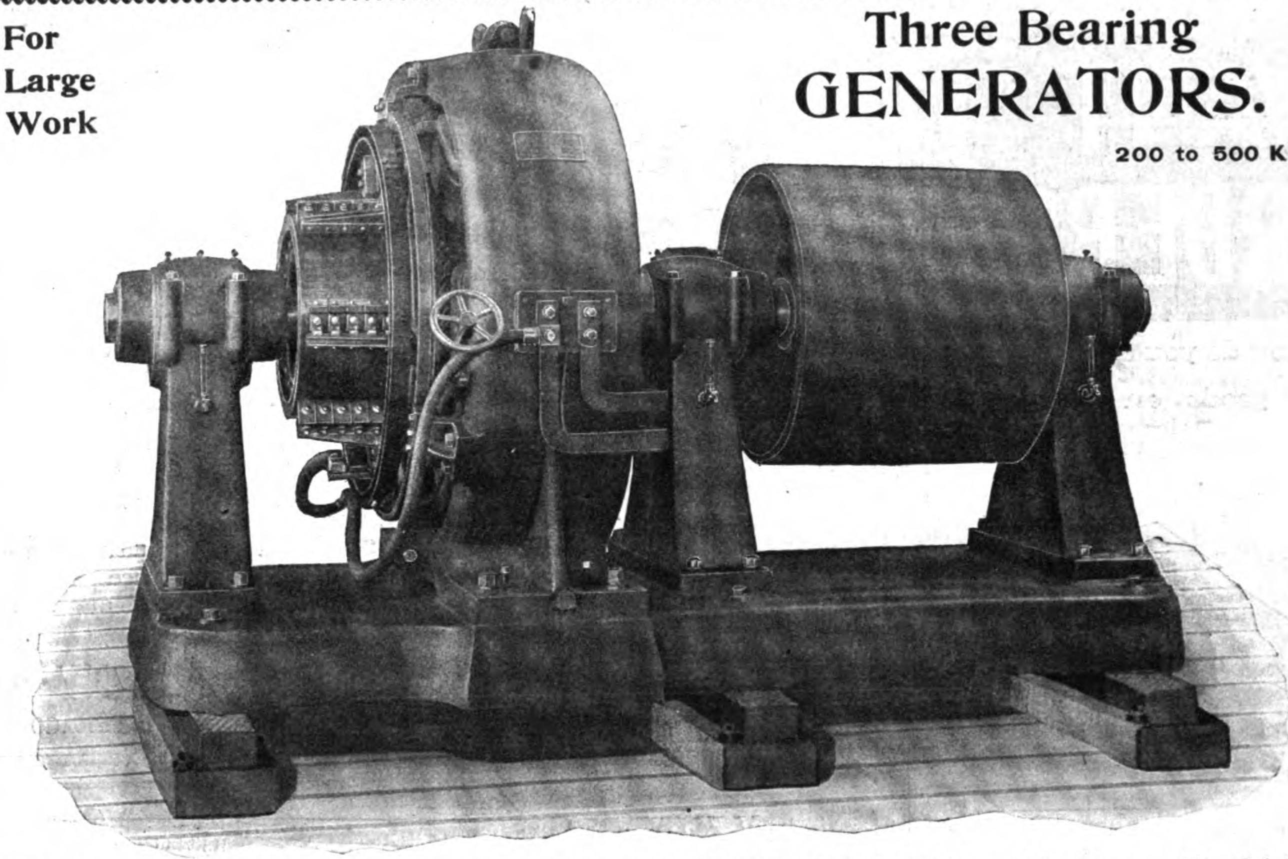
AKRON ELECTRICAL MFG. CO.,
AKRON, OHIO, U. S. A.



ENGINE TYPE GENERATOR.
6 Pole, 75 K. W., 275 R. P. M.

For
Large
Work

Three Bearing
GENERATORS.
200 to 500 KW.



Send for
Catalogue "A."
THE TRIUMPH ELECTRIC CO., Cincinnati, Ohio.

IN WRITING TO ADVERTISERS PLEASE MENTION THE AMERICAN ELECTRICIAN.

WIRT
RHEOSTATS
BRUSHES
INSTRUMENTS.
THE WIRT ELECTRIC CO., 4523 Tacony St., Philadelphia.

WRITE "EDDY"

In the electrical contract for any building requiring the highest grade generators and motors. The EDDY GENERATORS are built direct-coupled or belted.

Electrical engineers and contractors may receive EDDY illustrated bulletins regularly by filing their names and addresses at the Windsor office.

Special information cheerfully supplied.

THE EDDY ELECTRIC MANUFACTURING CO.,
WINDSOR, CONN.

NEW YORK: 149 Broadway.
CHICAGO: Marquette Building.

WANT ORDERS?

If you do you should have your goods on exhibition where they will be seen by buyers.

The Exhibition Department of The Bourse presents an opportunity to maintain a Profitable, Permanent Exhibit in the business centre of the city. This opportunity has been taken advantage of by large numbers of manufacturers from all parts of the United States.

18,000 square feet devoted to the display of Mechanical and Electrical Appliances.

Spaces from 20 feet square upwards can be rented with Steam, Electric, Gas or Water Power.

Exhibition Department
THE BOURSE
Philadelphia

ARE YOU A MASON,
AN ELK,
A FORESTER, or
AN ODD FELLOW?

You would indeed be an **odd-fellow** if you were in the market for

ELECTRICAL SUPPLIES

and did not place an order with us. Our goods are delivered

STRICTLY ON TIME,

this point being at once our **specialty,** and the surprise and envy of all competitors. We handle everything in the way of **electrical** goods, and they are absolutely reliable, to say nothing of the prices, which are the lowest. Our new 1901 Catalog is out and is a **winner.** Write for it.

ALDEN ELECTRIC COMPANY

The up-to-date Supply House, 52-54 W. VAN BUREN ST., CHICAGO

"Why and How"

Do you wish to understand the principles, methods, and history of the every-day industrial, technical, and scientific processes and operations that you have seen and wondered at? How done, and Why done in certain ways?

SCIENCE AND INDUSTRY

We explain the things everyone wants to know. Our articles are both interesting and accurate—a combination not found in any other popular-science publication in print. **Send 25 Cents in Stamps for a Three-Months' Trial Subscription. You will like us.**

SCIENCE AND INDUSTRY,

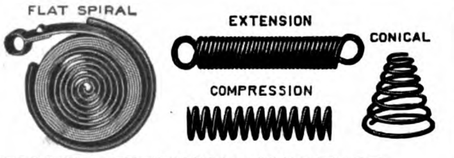
$1.00 PER YEAR.
An Illustrated Monthly Magazine. SCRANTON, PA.

LINEMEN'S TOOLS.

That little book of tools, in the interest of everyone connected with line building, *sent free,*

MATHIAS KLEIN & SON,
87-89 W. Van Buren Street, CHICAGO, ILLS.

When writing to advertisers please mention the
AMERICAN ELECTRICIAN.



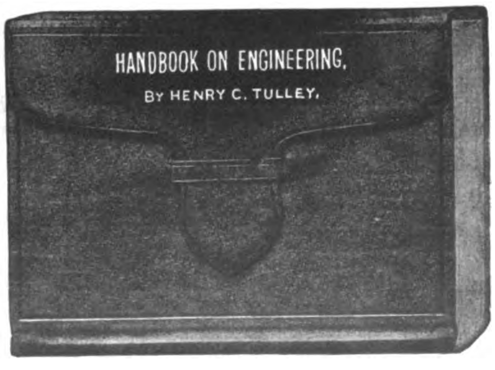
CARY SPRING WORKS,
240 and 242 W. 29th St., New York City.
MANUFACTURERS OF...
WIRE AND SPRINGS OF ALL KINDS.
Telephone 3346 38th Street.

HAIR SPRINGS.

Non-Magnetic Hair Springs of **Phosphor Bronze** and other non-magnetic metals.

Hair Springs of any description manufactured to order. F. N. MANROSS, Forestville, Conn.

JEFFREY ELEVATING, CONVEYING, POWER TRANSMISSION MACHINERY FOR CATALOGUE, ADDRESS THE JEFFREY MFG. CO. COLUMBUS, O.



HANDBOOK ON ENGINEERING.

For steam users, engineers, electricians, machinists, and firemen. The most complete manual published; embracing all the recent improvements and the practical care and management of dynamos, motors, boilers, engines, pumps, inspirators and injectors, refrigerating machinery, hydraulic elevators, air compressors and all branches of steam engineering. It is the most comprehensive and best illustrated book ever published. It is nicely bound in leather, pocket-book style, and contains about 800 pages, with over 300 illustrations. In it can be found the questions most likely to be asked when under examination before being licensed as an engineer.

The author is **HENRY C. TULLEY**, who has been an engineer for the past 25 years, and a member of the Board of Examiners of St. Louis, Missouri, for 8 years.

Sold by HENRY C. TULLEY & CO., Wainwright Building, St. Louis, Missouri.

Sent to any address on receipt of price, $3.50; payable by registered letter, post office money order, currency or stamps. MONEY refunded if NOT SATISFACTORY. Write for circular.

"We should
be only too glad to
speak well of this Lubricator."
—*Milwaukee Elec. Ry. & Lt. Co.*
J. I. Beggs, General Manager.

NATIONAL AUTOMATIC FORCED-FEED CYLINDER LUBRICATOR

Position of Reservoir when empty.
Position of Reservoir when filled

STANDS INSPECTION—
BUT NEEDS NO WATCHING
WRITE US FOR CATALOGUE.
STEPHENSON
MFG. CO.,
ALBANY, N. Y.

CLING-SURFACE
THE DAYS OF TIGHT BELTS ARE OVER
CLING SURFACE MFG CO.
BUFFALO, N.Y., U.S.A.

ONE PACKAGE
OF
CLING-SURFACE

will prove that it will stop all slipping of your belts and permit them to be run easy under full load, increase their output and put them in perfect condition.

And it will do this without making the belts sticky.

We guarantee it.

This package is to go simply on trial.

If it is not satisfactory after use send it back and pay nothing, not even for what you have used, while we pay freight both ways.

You only keep it if it does the work.

Isn't that worth investigating when it is at our risk?

WRITE US.

CLING-SURFACE MFG. CO.
188-194 Virginia Street
BUFFALO, N. Y.
New York, Boston, Philadelphia, Chicago,
St. Louis, Toronto, New Orleans.

NOISELESS GEARS

WE ARE PATENTEES AND
SOLE MANUFACTURERS OF

New Process Pinions.

They are noiseless, durable, cleanly, are non-conductors of electricity, greatly reduce vibration and do not appreciably wear the metal gear wheels with which they mesh. We make them in both spurs and bevels up to 48 in. diameter, and have pinions in operation transmitting over 450 horse power. We plane the teeth of our bevel gears accurately to cone lines.

WE ALSO MAKE METAL GEARS.
SEND FOR OUR CATALOGUE.

The New Process Raw Hide Co.
SYRACUSE, N.Y.

H.J. Ormsbee Eng. Co.

Daniel's P. P. P.
Rod Packing

For Seven Years Has Held the Highest Place of Packing Superiority and has proven to be Best wherever a Rod Packing is needed.

Beware of Imitations

Purchase only the Genuine.

PISTON PACKING PERFECT WARRANTED
TRADE MARK
P.P.P.
Registered

Look for Trade Mark on Box and Wrappers.

Pat. Aug. 7, 1894.

Composed of Sliding Wedges to compensate for wear or any inequality of Rod or Box. Oil Cushions to Lubricate and enamel the rod.

Write for General Catalog No. 5.
Send for "P. P. P." Booklet and Pencil.

Quaker City Rubber Co.,
409 Market St., Philadelphia.

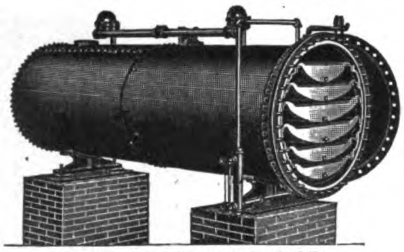
Hoppes
Steam
SEPARATORS
FOR EITHER
Live or Exhaust Steam.

Dry Steam
Guaranteed without friction.

NEW THING.
The Gutters do the work without friction.

Hoppes
Exhaust Steam Feed-Water
Heaters
MAKE FEED-WATER BOILING HOT.

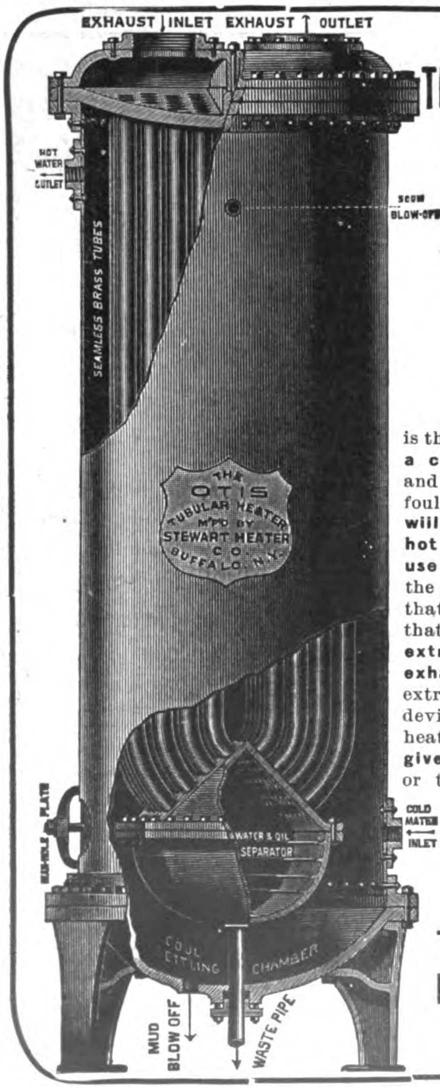
Hoppes Live Steam Feed-Water Purifiers
QUARANTEED TO KEEP BOILERS CLEAN.



LIVE STEAM PURIFIER.

CATALOGUE
OF ALL
FREE

HOPPES MFG. CO.,
67 LARCH ST.,
SPRINGFIELD, OHIO,
U. S. A.



The OTIS
Tubular
Feed Water
Heater and
Purifier...
with Seamless Brass Tubes

is the only heater that has **a cool settling chamber** and is **guaranteed** not to get foul with scale, and that **will continue to heat as hot after years of constant use** as when new. This is the only feed water heater that has an oil separator that is **guaranteed to extract more oil from exhaust steam** than can be extracted by any other device in the market. This heater is **guaranteed to give perfect satisfaction** or the manufacturers **will pay all cost** of placing and removing, also freight both ways.

FOR PRICES AND
DISCOUNTS WRITE

THE STEWART
HEATER CO.,
16 Norfolk Ave.,
BUFFALO, N. Y.

The Austin Separator
.... FOR ....
Live and Exhaust Steam

is the practical, profitable Separator for you to buy. Its use guarantees increased efficiency in your engine. and a saving through the perfect cleansing of your exhaust for boiler and other uses.

Made in many styles, covering the whole field of steam usage—in one quality, the best. Thousands in use in the United States and Canada.

Shipped to responsible concerns on 30 days' trial, to be returned at our expense if not satisfactory.

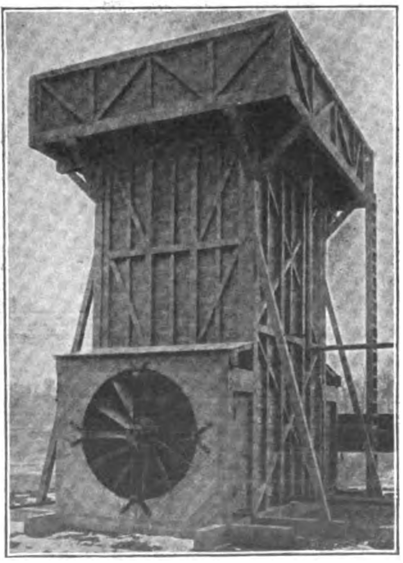
Austin
Separator
Company
19-25
Woodbridge
Street.
DETROIT, MICH.

FIGURE B

L. L. CLINE

When writing to advertisers please mention
AMERICAN ELECTRICIAN.

COOLING TOWERS
(GRADIRWORKS)
Furnished with Fans or Chimneys (Natural Draft)
APPARATUS for the RECOOLING of AMMONIA
and STEAM CONDENSER WATER



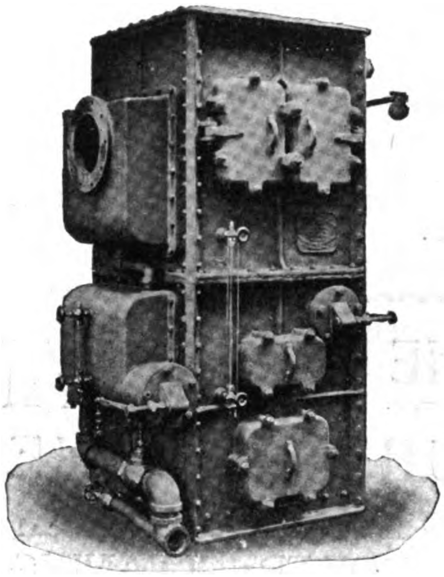
Saves from 90 to 95 per cent. of water. Highest efficiency, lowest temperatures guaranteed.

References from leading firms all over the United States.

Payment in installments according to saving of fuel and water agreed to.

I furnish, in connection, condensers of every kind and description, steam engines, electric motors and pumping machinery.

GEO. J. STOCKER, Patentee and Manufacturer
2833 South Kingsh ghway Blvd., ST. LOUIS, MO.
WRITE FOR CATALOGUE.



With the Coming of Cold Weather

You may wish to utilize your exhaust steam for heating your buildings. Right here we can be of service, as we design and build appliances for getting the fullest value out of exhaust steam by purifying it from cylinder oil, by heating and removing the scale from the feed-water, by arranging for the surplus exhaust not required in heating the water to pass on to the heating system, and for taking care of the condensation returned, all in a single appliance—compact, automatic, reliable, inexpensive to install, most durable and simpler in operation than any other system.

You have doubtless heard of our COCHRANE HEATERS. We make two styles or types, those for use in connection with engines, exhausting free to the atmosphere at all times, and the

"COCHRANE"

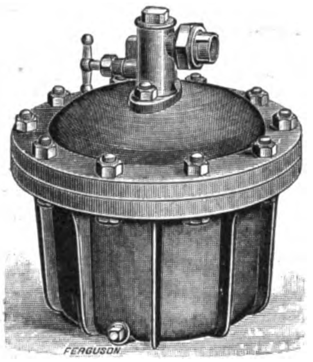
Special Feed-Water Heaters and Receivers,

which are adapted for use in connection with any kind of an exhaust steam heating system.

Our Heater literature is at your service. Shall we send you Catalogue I-H, free, postpaid?

Harrison Safety Boiler Works

3124 N. 17TH STREET, PHILADELPHIA, PA.



STEAM TRAPS

NEW FEATURES:
Wearing Parts, Valve and Seat Renewable.
For High Pressure.

We manufacture Steam Traps for all duties, High and Low Pressures, returning the Condensation back into Boiler or discharging to Hot well, Tank or Atmosphere. Also for use on extra high pressure in Electric Light Plants, etc.

Send for Catalogues A, B and C.

ALBANY STEAM TRAP CO.,

64 Church Street,
ALBANY, - - N. Y.

Flexible Metallic Tubing

COPPER OR STEEL,

For handling Steam, Compressed Air, Water, Gas, Oils, Etc.

Built to Stand any Internal Pressure.

PRACTICALLY INDESTRUCTIBLE.
PERFECT SUBSTITUTE FOR RUBBER HOSE.
UNAFFECTED BY CLIMATIC VARIATIONS.
A REVOLUTION IN FLEXIBLE TUBING.

Flexible as Rubber Hose. Lasts Indefinitely.
Will Stand Tons of External Pressure.
Will Not Kink, Crush or Char.

ALBANUS L. SMITH & CO.,

Agents, Importers and Dealers. 1305 ARCH ST., PHILADELPHIA, PA.

Wright Improved Safety Water Columns

STAND FOR

ECONOMY OF FUEL; ECONOMY OF BOILER REPAIRS
INCREASED DURABILITY OF BOILERS;
SAFETY TO LIFE AND PROPERTY.

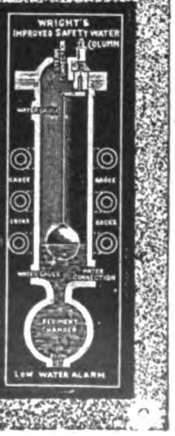
As an investment they pay for them selves several times over each year—not an empty statement; but a proven fact. We also make the Wright Emergency Steam Trap, a wasteless trap of wonderful capacity.

Let us send full particulars.

Wright Emergency Steam Trap.

WRIGHT'S IMPROVED SAFETY WATER COLUMN
GAUGE
COCKS
SEDIMENT CHAMBER
COMBINED HIGH AND LOW WATER ALARM

Wright Manufacturing Company
24 Shelby St.
Detroit, Mich.



What Does Electrical Horse Power Cost?

Have your BOILERS anything to do with it? Is your COAL BILL of any consequence? Are you in a position to audit your FUEL ACCOUNT and repairs? Do you deduct and add to this the WEAR and TEAR on your boilers? Or may be you do not care HOW LONG your BOILERS LAST?

Mineral Analysis of Water and Proposition Free.

DEARBORN BOILER PREPARATIONS——RESULTS——INVESTIGATE.

Water Chemists. Oil Chemists. General Chemists.

DEARBORN DRUG & CHEMICAL WORKS,

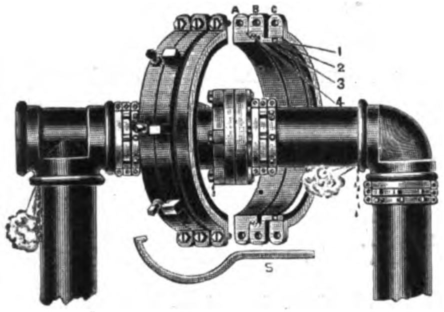
WM. H. EDGAR, President.

Manufacturing and Analytical Chemists. Analyzers of Everything. Makers of Boiler Compounds.

OFFICES: 27, 28, 29, 30, 31, 32, 33 & 34 Rialto Bldg. WORKS: 2325-27-29 La Salle St.

Telephone: Harrison 1373. **CHICAGO, ILL.** Telephone: 1130 South.

IT IS NOW TIME TO THINK OF FALL REPAIRS



Stop the Leaks at Pipe Joints with

The Climax Steam Joint Clamp...

Send for full particulars, testimonials and prices to

JAMES McCREA & CO.

MFRS. OF STEAM SPECIALTIES......

67 W. Washington St., CHICAGO

AG NTS.—Barrett & Plowman, 11 N. Front St., Philadelphia; Geo. I. Roberts & Bros., 171 Fourth Ave., New York; Kelly & Jones Co., Pittsburg, Pa.; C. K. Nichols & Co., 40 Water St., Boston; Knight & Jillson Co., Indianapolis Ind.; Western Iron & Supply Co., St. Louis, Mo.; The Mine & Smelter Supply Co., Denver, Colo.; Pierce Bird & Co., 31 Main St., San Francisco.

"DARLING" VALVES

PATENTED

Have Double Revolving Gate Discs, Compound Equalizing Wedges and Parallel Seats.

NO OTHER VALVE HAS ALL THESE FEATURES.

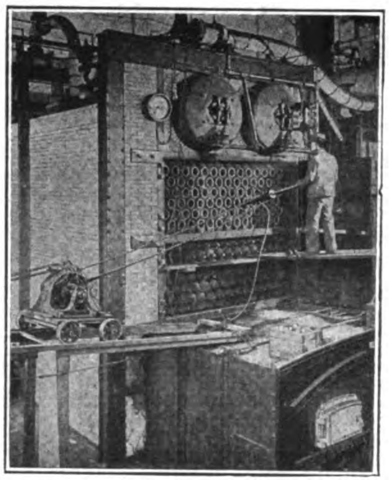
See article in "American Electrician," May, 1901, page 249.

THE DARLING PUMP & MFG. CO., Ltd., 1 Campbell St., Williamsport, Pa.

THE WEINLAND TUBE CLEANERS

A Necessity in Economical

BOILER CLEANING



THIS shows the way it is done at Edison Electric Light Co., at Columbus, O. 350 H. P. B. & W. Boiler), with our **Mechanical Cleaner** and 5 **Horse-Power Electric Motor,** cleaning 18 feet 4 inch tubes in 3 to 6 minutes, removing every particle of scale, leaving tubes clean and bright as when new.

A GREAT MACHINE

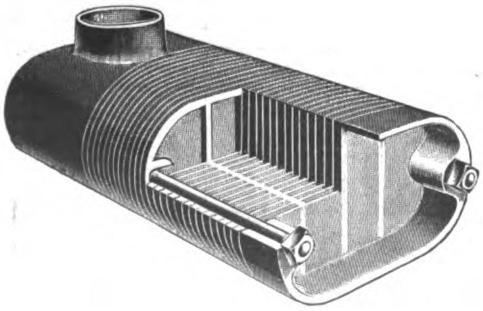
SAVES
TUBES! COAL!
LBOR! TIME!
MONEY!

BOILER CLEANERS our Specialty for all Water Tube, also Return Tubular Boilers. We make **Hand and Turbine Cleaners,** sell or rent machines, or clean by contract.

GET OUR HANDSOME CATALOGUE AND FULL PARTICULARS

THE LAGONDA MFG CO., Springfield, Ohio

The Original MESH SEPARATOR for Boilers



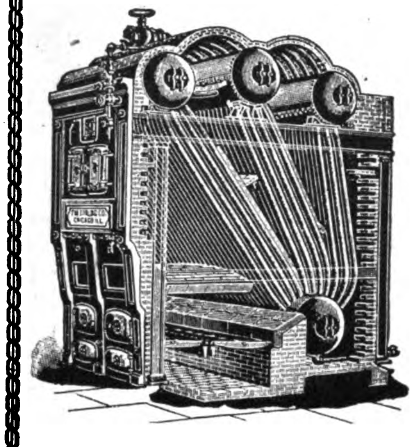
No Steam Plant Is Complete unless the BOILERS are equipped with the

Potter Mesh Separator and Superheater

Replaces old type of ineffective dry pipe. Converts wet steam into absolutely dry steam. Prevents damage to engine by water. Particularly adapted to boilers in electric light and power plants. In use in THOUSANDS of HORSE POWER of Boilers.

Catalog No. 28-A explains it. Send for a copy.

JAMES BEGGS & CO., 9 Dey Street, New York, N. Y.



STIRLING WATER TUBE SAFETY BOILERS

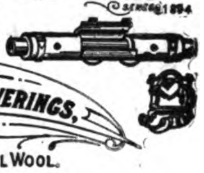
Nearly 1,000,000 H. P. In use.

THE STIRLING COMPANY,

General Offices: Pullman Building, Chicago.

EASTERN AGENCIES:

NEW YORK CITY, A. L. Rogers, 26 Cortlandt Street.
BOSTON, J. A. Shepherd, 631 Exchange Building.
PHILADELPHIA, Jas. Meily, Betz Building.
PITTSBURG, W. S. Elliott, Germania Bank Building.



STEAM PIPE AND BOILER COVERING

Buffalo Office 13 TERRACE. TELEPHONE CAL. SENECA 1894

ROBERT A. KEASBEY,

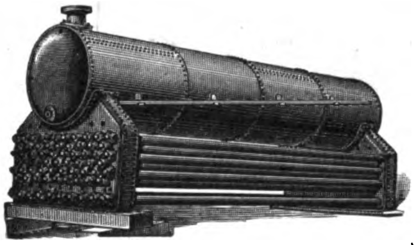
K & M. MAGNESIA & MAGNABESTOS SECTIONAL COVERINGS,

HEADQUARTERS FOR HAIR FELT, MINERAL WOOL, ASBESTOS PAPERS, BRINE PIPE COVERINGS, ETC.

83 WARREN ST., New York City

TELEPHONE CALL, 1515 CORTLANDT.

Estimates Furnished and Contracts Executed.



Heine Safety Boiler Co.,

421 Olive Street, ST. LOUIS, MO.

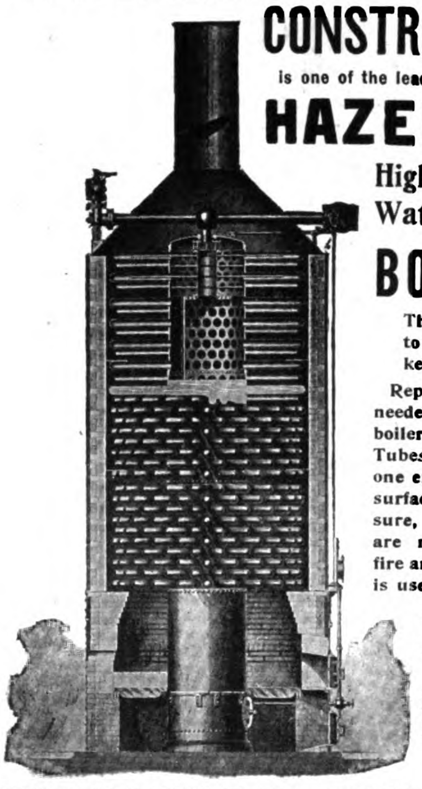
SHOPS AT

Phoenixville, Pa., St. Louis, Mo., Chicago, Ill.

Modern Water Tube Boilers.

ECONOMICAL SAFE. DURABLE.

150 H. P. Boiler ready for shipment.



CONVENIENT CONSTRUCTION

is one of the leading features of

HAZELTON

High Pressure Water Tube

BOILERS

They are easy to examine and keep clean.

Repairs are seldom needed because our boilers are well made. Tubes are fastened at one end only, no flat surfaces under pressure, riveted joints are not exposed to fire and no cast metal is used.

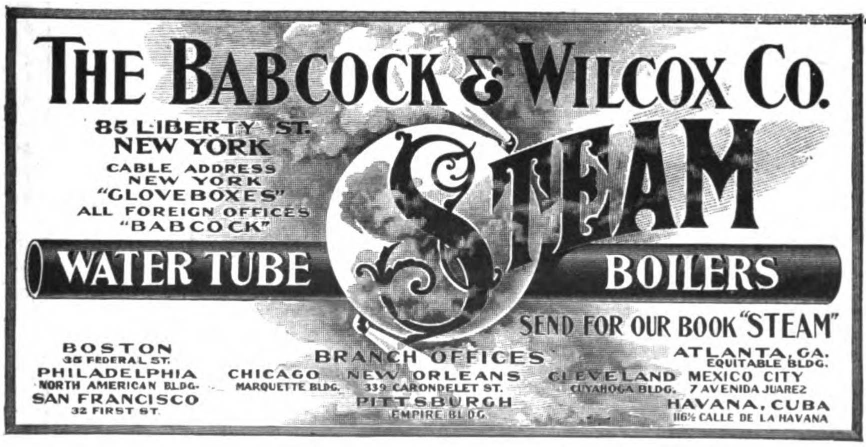
We also make Stacks, Tanks and Miscellaneous Metal Work.

Write us.

THE HAZELTON BOILER CO.

RUTHERFORD, N. J.

Cable Address "Paila," N. Y. Telephone, 6M Rutherford.



THE BABCOCK & WILCOX CO.

85 LIBERTY ST.
NEW YORK
CABLE ADDRESS
NEW YORK
"GLOVEBOXES"
ALL FOREIGN OFFICES
"BABCOCK"

WATER TUBE STEAM BOILERS

SEND FOR OUR BOOK "STEAM"

BRANCH OFFICES

BOSTON
35 FEDERAL ST.
PHILADELPHIA
NORTH AMERICAN BLDG.
SAN FRANCISCO
32 FIRST ST.

CHICAGO
MARQUETTE BLDG.

NEW ORLEANS
339 CARONDELET ST.
PITTSBURGH
EMPIRE BLDG.

CLEVELAND
CUYAHOGA BLDG.

ATLANTA, GA.
EQUITABLE BLDG.
MEXICO CITY
7 AVENIDA JUAREZ
HAVANA, CUBA
116½ CALLE DE LA HAVANA

THE BABCOCK & WILCOX COMPANY
STEAM

The Babcock & Wilcox Company, 85 Liberty Street, New York, will send an illustrated book on "STEAM," to all interested, upon application.

Capital Stock, $100,000.00

No.

Incorporated under the laws of Delaware.

The American Workingman's Protective Association, of Delaware, (Incorporated)

Offices

Detroit Michigan. Dover Delaware.

WE FIGHT YOUR CLAIMS

MONEY AGAINST MONEY
CAPITAL AGAINST CAPITAL

If you are injured or killed we protect the interests of yourself or heirs, with the best local and foreign legal talent.
We will fight your claims from the lowest to the highest courts.
The results of the decision of the courts are yours.
It costs you a small sum yearly for this protection, nothing more.
For further information write

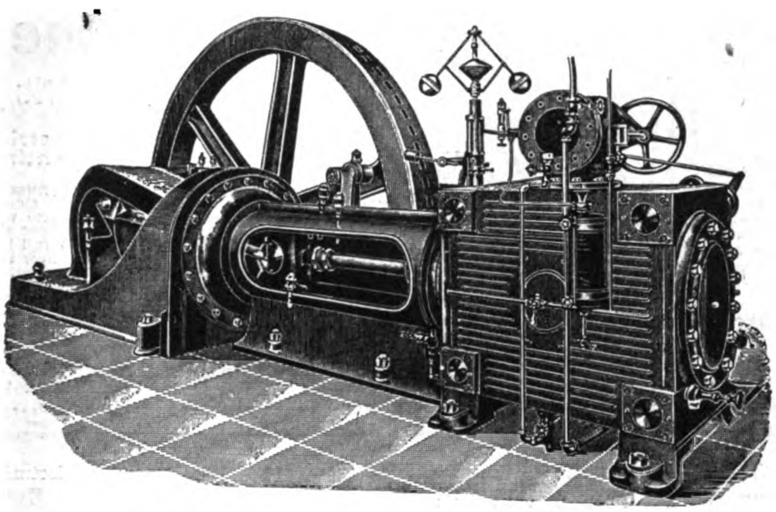
THE AMERICAN WORKINGMEN'S PROTECTIVE ASSOCIATION,

66 Buhl Block, DETROIT, MICH.

The Names of the Company's Officers are a Guarantee as to its Business Standing.

HAMILTON CARHARTT, President,
Manufacturer of The Carhartt Overall.
HENRY C. BARTER, Vice-President.
Gen'l Sec -Treas. International Longshoremans' Assn.
SIDNEY A. WITHERBEE, Treasurer. GEO. G. PRENTIS, Secretary.

AGENTS WANTED!



St. Louis Corliss Engine

For Electric Lighting, Electric Railways, Rolling Mills, Factories, Etc.

Complete Steam Plants
Designed, Built and Installed.

BUILDERS,
ST. LOUIS IRON and MACHINE WORKS,
ST. LOUIS, MISSOURI.

Eastern and Foreign Sales Department,
FRANK M. PIERCE ENGINEERING CO.,
26 Cortlandt St., New York, N.Y.

McINTOSH & SEYMOUR ENGINES

ALL SIZES

SIMPLE, COMPOUND. TRIPLE EXPANSION. | HORIZONTAL. VERTICAL. | TANDEM. CROSS. | BELTED. DIRECT COUPLED TO DYNAMO OR SHAFT.

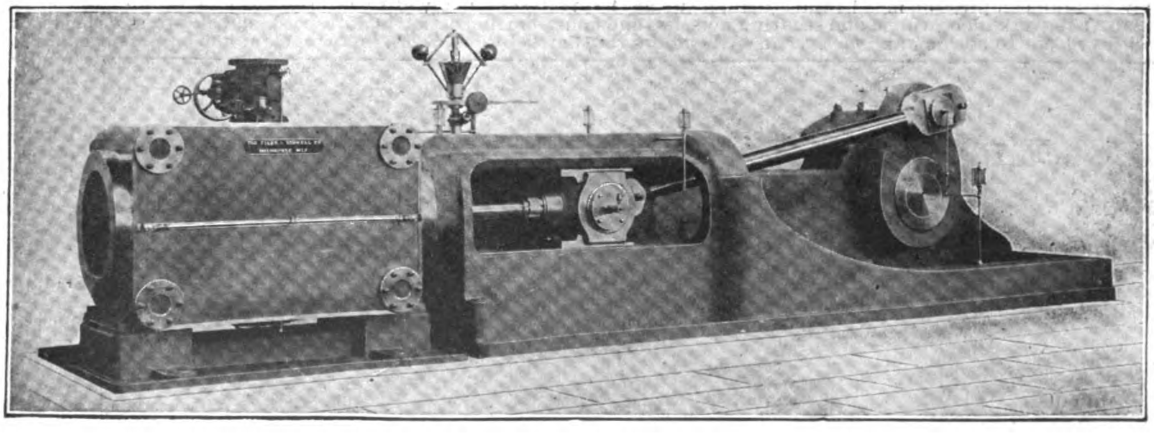
SPECIAL ENGINES TO MEET ALL REQUIREMENTS.

McINTOSH, SEYMOUR & CO.,
AUBURN, N. Y.

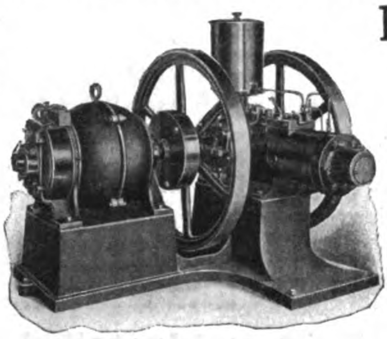
NEW YORK, McIntosh, Seymour & Co., 26 Cortlandt St.
SAN FRANCISCO, Charles C. Moore & Co., 32 First St.
BOSTON J. A. Grant & Co., 8 Oliver St.

SOUTHWARK FOUNDRY & MACHINE COMPANY,
PHILADELPHIA, PA.
PORTER-ALLEN AUTOMATIC STEAM ENGINES
for Driving Electrical Generators Direct Connected or by Belt.

THE **FILER & STOWELL CO.,** Milwaukee, Wis., U. S. A.,
Builders of... **HEAVY DUTY CORLISS ENGINES.**



Eastern Representative, T. W. PHILLIPS, 4 Market Square, Providence, R. I.



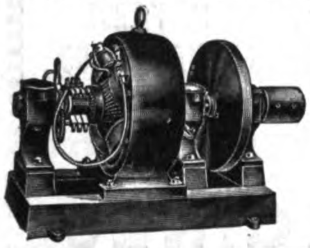
The MIETZ & WEISS GAS and KEROSENE ENGINE.

Burns **KEROSENE** cheaper and safer than gasoline. Automatic, simple and reliable. No electric battery or flame used. Perfect regulation. Belted or directly coupled to dynamo for electric lighting, charging storage batteries and all other power purposes.

Send for Catalogue.

MARKT & CO., Ltd.,
London, Hamburg and Paris.

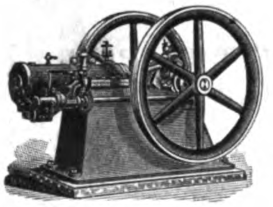
A. MIETZ,
128-138 Mott St., N. Y. City.



Gas Engine Dynamo,
Three-Bearing Type.
The only style of Dynamo suitable for Gas Engine work.

Absolutely Even Lights.
No Countershaft.

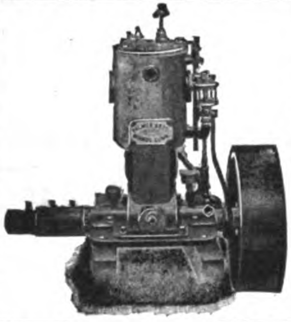
THE HOBART ELECTRIC MFG. CO.
60 SIMPSON ST., TROY, OHIO.



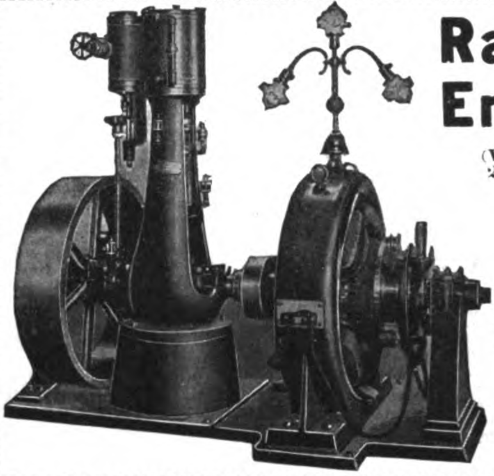
GAS and GASOLINE.... ENGINE. **Observe its Simplicity.**

No complicated mechanism on the back side or within the bed.
Takes up its load on any revolution.
Specially adapted to electric light or general service. Send for circular "A."

COLUMBUS MACHINE CO.,
COLUMBUS, OHIO.



Palmer Stationary and Marine
Gasoline Engines
AND LAUNCHES.
LAUNCHES IN STOCK.
Bicycle Engine Castings.
SEND FOR CATALOGUE.
PALMER BROS.
MIANUS, CONN.



Racine Engines
(Vertical Only.
2 to 37 H. P.)
FOR
Electric Lighting.

Direct Connected or Belted. Guaranteed to regulate within 1½ per cent from no load to full load. Write for New Illustrated Catalogue.

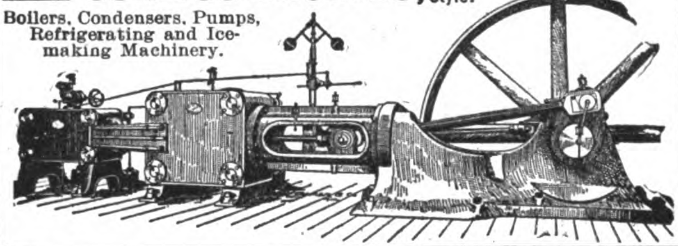
RACINE HARDWARE CO.,
300 RACINE ST.,
RACINE WIS.

The Engineer of the electrical plant of a large manufacturing establishment writes:

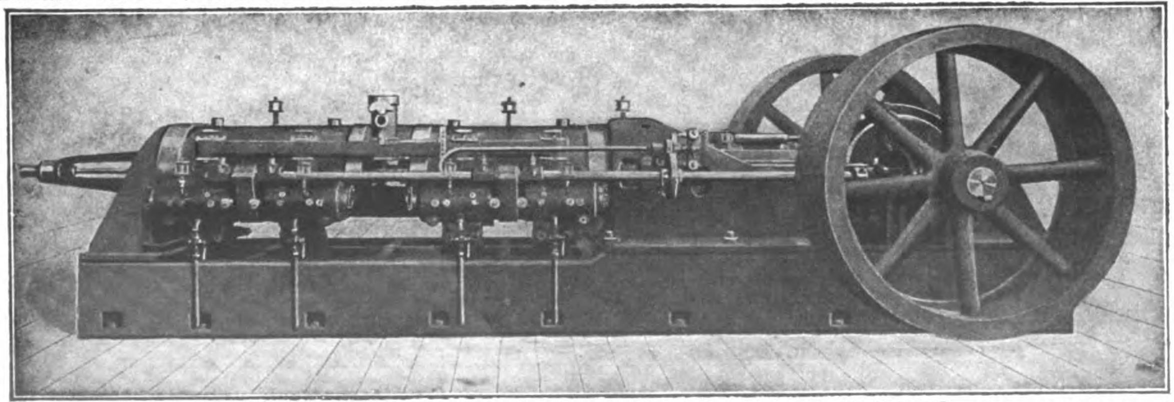
"The advertisement of * * * * * in the American Electrician, was the means of this firm putting in one of their 300 h. p. Corliss Engines."

Samples Free OF OUR PATENTED
PIPE COVERING
AND CORRUGATED
COPPER GASKETS
For Steam Joints.
UNITED STATES MINERAL WOOL CO.,
143 LIBERTY ST., N. Y.

THE VILTER MFG. CO. {847 Clinton St., Milwaukee, Wis.
Improved **CORLISS ENGINES,** Any Style.
Boilers, Condensers, Pumps, Refrigerating and Ice-making Machinery.



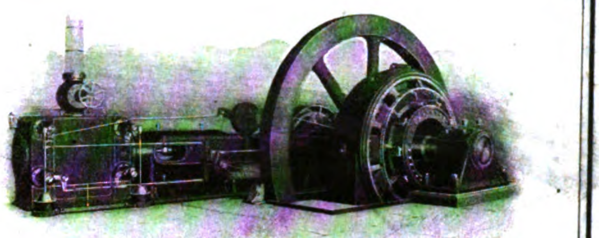
DOUBLE ACTING TANDEM GAS ENGINES **For use in Electric Lighting or for Driving Railway Generators, Belted or Direct-Connected.** Built in standard sizes from 15 H.P. up to 2,100 H. P., or larger to order. Quick delivery up to and including 400 H. P. rated or 600 H. P. actual. Engines put in on approval for responsible parties either in new plants or to replace steam engines. Two regular impulses each revolution. Governing effected by throttling a mixture of constant strength. Ball-bearing Governors. Speed regulation within 2 per cent. from no load to full-rated brake load. Each engine tested to overload on large generators. Variation in angular velocity guaranteed to be within 1½ per cent., or within ⅛ of a degree. Speed changed at the switchboard. Engines adapted for and guaranteed to operate perfectly on natural, illuminating or producer gas, on 10,000 B. T. U. per H. P. hour. Patterns on hand for sizes up to and including 1,000 H. P. All wearing parts are adjustable for wear. Strictly high-grade workmanship and the very best of material only is used. All parts made interchangeable and replaceable. All repairs free for two years unless damage is caused by accident or carelessness. All surfaces exposed to internal heat are thoroughly water-jacketed. This includes the hollow pistons and nickel steel piston rods (through which a constant stream of water is flowing), the valve seats, valves, cylinders and cylinder heads. Consequently very high compression may be and is used, insuring the greatest economy of fuel, absorbing all inertia from the reciprocating parts, minimizing the work on bearings, and securing noiseless and non-vibrating action at full speed, and on excessive loads, or on instant changes from heavy loads to nothing and *vice versa*. All engines rated at 45 lbs M. E. P., but capable of and proportioned for loads requiring 80 lbs. M.E.P. These engines are especially adapted for use in small electric street railway stations where the variation in load is violent and excessive, and where large momentary overload capacity is imperative.



This is the type of engine that runs on less than one pound of coal per Brake H. P. hour, when a Taylor Gas Producer is used.

STANDARD AUTOMATIC GAS ENGINE COMPANY, OIL CITY, PA., U. S. A.

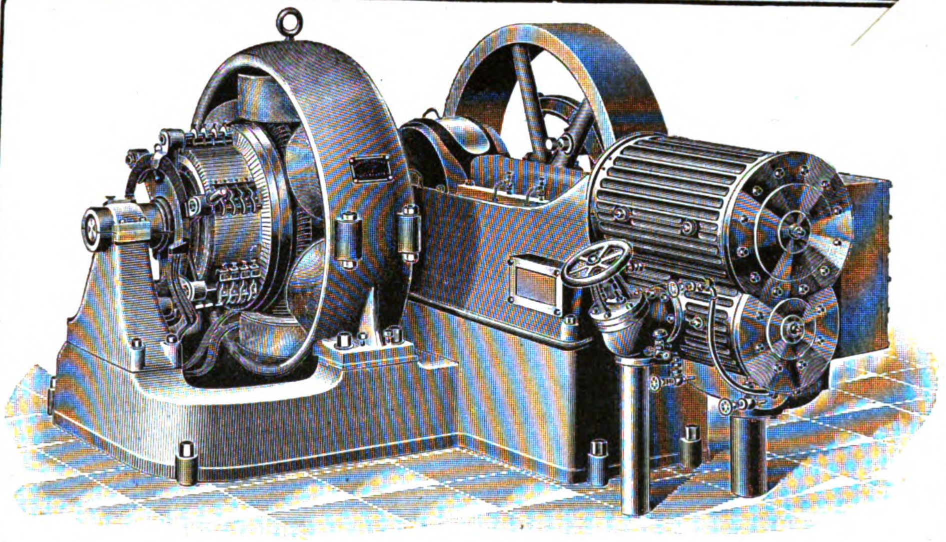
RICE & SARGENT and IMPROVED GREENE ENGINES



Are the product of the best mechanical skill and have the preference with the most exacting users.
Our engines are furnishing power for electric light and railway plants, alternating (parallel operation) and direct current mills and factories of every description. Our product is preferred for any use requiring highest economy, best mechanical efficiency, and utmost delicacy of speed regulation. We are the sole builders of the above engines and solicit correspondence with those wishing to get maximum power results

Cable Address: "Greene," Providence. **Providence Engineering Works,** Successors to Providence Steam Engine Co., also to Rice and Sargent Engine Co. Providence, R. I.

FOR ECONOMY USE American-Ball Duplex Compound Engine and Direct-Connected Generator.

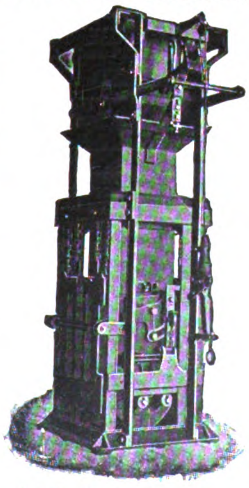


A SAVING of fuel of 25 per cent. over the simple engine without condenser.
Less cost of maintenance than any other compound engine, because there are fewer parts to maintain.
No more floor space than a simple engine. You can't afford to take a simple engine as a gift.

We Make Engines, Generators and Motors.

AMERICAN ENGINE COMPANY
46 RARITAN AVE., BOUND BROOK, N.J.
NEW YORK OFFICE, 95 LIBERTY STREET.

TRADE PAPER ADV. AGENCY, N.Y.



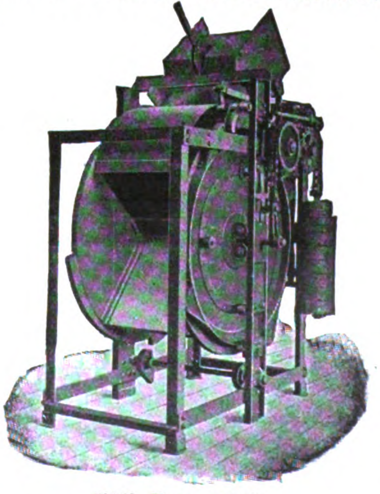
200-lb. Vertical Scale.

Clarke Automatic Scales
For Weighing Coal
IN
Electric Light and Power Plants
are in use in several large Electric Light and Power Stations, and have received the highest endorsement from Engineers and Managers.

CORRECT WEIGHT AUTOMATICALLY AND ACCURATELY RECORDED OF ALL COAL RECEIVED AND USED. . . . .

WRITE FOR INFORMATION AND PARTICULARS.

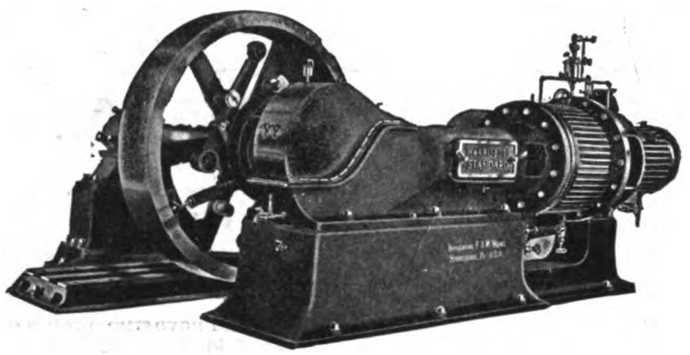
Clarke Automatic Scales Company
NO. 29 BROADWAY, NEW YORK.



500-lb. Rotary Scale.

Harrisburg Engines

6 TO 3,000 HORSE POWER HIGH SPEED
MEDIUM SPEED AND CORLISS



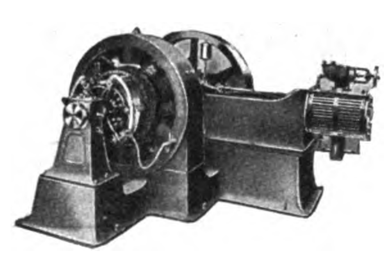
HARRISBURG STANDARD TANDEM COMPOUND ENGINE
DIRECT CONNECTED STYLE

Harrisburg Foundry and Machine Works
HARRISBURG, PA., U. S. A.

SKINNER ENGINES

FOR EXACTING SERVICE.

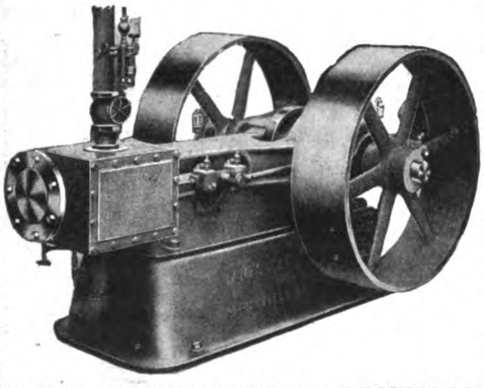
Side or Center Crank.
Belted or Direct-Connected.
Simple or Compound.
Medium or High Speed.



THE VERY LATEST DESIGNS——THE VERY BEST CONSTRUCTION.

SKINNER ENGINE CO., : : : : Erie, Pa., U. S. A.

AUTOMATIC ENGINES



Of 10 to 50 H. P., with finest Governing System. Guarantee best possible regulation, with highest economy in steam. Particularly well adapted for

ELECTRIC LIGHT AND POWER

Pamphlet with full information, by stating wants and addressing
JAMES LEFFEL & CO., Box 62, Springfield, Ohio, U.S.A.

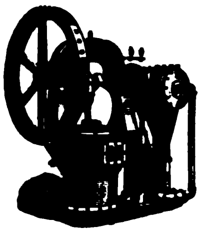
Notice to Advertisers!

CHANGES OF COPY Must be in this office not later than the 15th of each month. We cannot insure changes of copy being made or advertisements being withdrawn after that date, as advertising forms begin going to press the 15th.

NEW ADVERTISEMENTS Can be inserted if received by the 25th of each month, but to insure proper classification they should be in this office by the 15th.

To mail the paper promptly on the first of each month it is necessary for us to adhere strictly to the above and we will appreciate the co-operation of advertisers in our effort to insure the punctual appearance of the paper.

AMERICAN ELECTRICIAN, Beard Building, N. Y.



CONOVER CONDENSERS

DUTY GUARANTEED.
Why not know how much steam your Condenser will consume?
Catalogue free.
THE CONOVER MFG. CO., 26 Cortlandt St., N.Y.

IMPROVED SCRAPING TOOLS

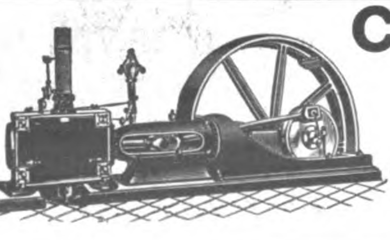
MOUND TOOL & SCRAPER CO.
MANUFACTURERS OF
FINE SCRAPING TOOLS.
FOR ENGINEERS AND MACHINISTS.
SPECIAL TOOLS FOR REMOVING PACKING FROM STUFFING BOXES OF ENGINES, PUMPS ETC. — FINE COLD CHISELS.
710-712 HOWARD ST. ST. LOUIS, MO.

Set of 6 Scraping Tools (Oak Case)	$2.50
Set of 6 Packing Tools (Nickel Plated)	2.25
Set of 5 Cold Chisels (high grade crucible steel)	2.00

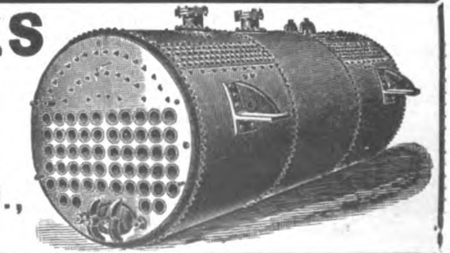
Send for Circular.

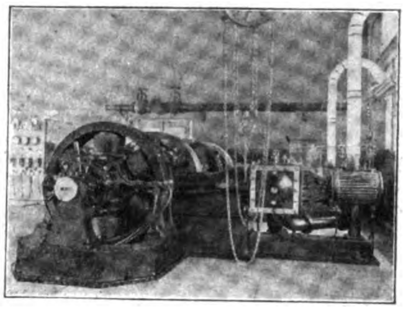
Mound Tool & Scraper Co.
712 Howard St., St. Louis, Mo.

Mail orders promptly attended to.



CORLISS ENGINES
HIGH PRESSURE BOILERS
TUBULAR and INTERNAL FURNACE
THE MURRAY IRON WORKS CO.,
BURLINGTON, IOWA.





BALL ENGINE CO.

ERIE, PA.

AUTOMATIC ENGINES

FOR

Electrical Service.

WILLIAMS VERTICAL COMPOUND

ENGINES

ESPECIALLY ADAPTED TO

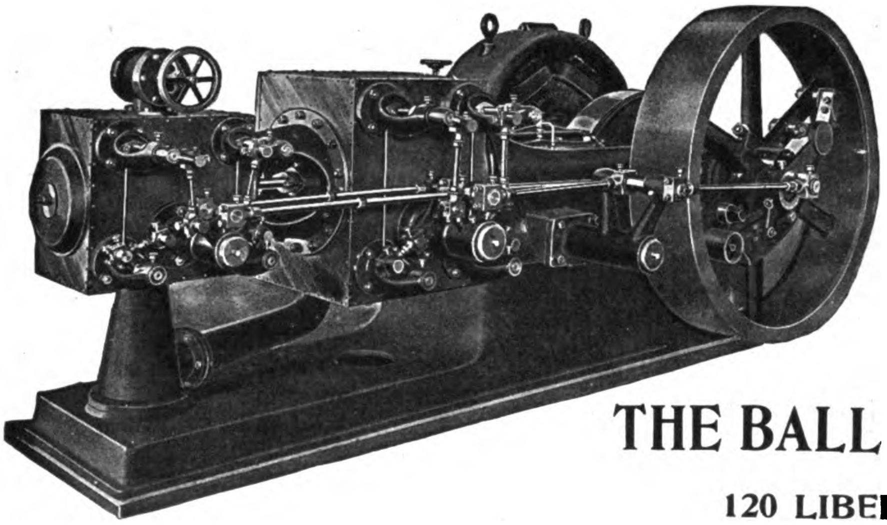
ELECTRIC LIGHT AND POWER SERVICE

400 TO 2,500 H.P.

PROMPT DELIVERIES.

QUINCY ENGINE WORKS

2901 SPRUCE ST., QUINCY, ILL.



NEW

Horizontal Tandem Compound Engine.

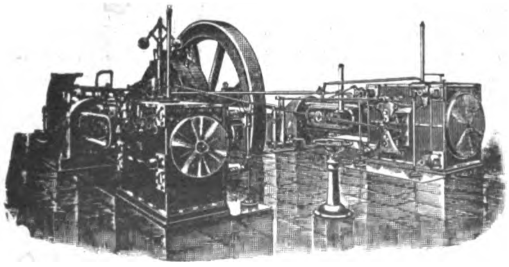
Combines the best features of the well-known Corliss type with those of our Standard Automatic Cut-Off Engines, resulting in the best possible distribution of steam and close regulation.

WRITE FOR PARTICULARS.

THE BALL & WOOD COMPANY

120 LIBERTY ST., NEW YORK.

THE C. & G. COOPER CO. MT. VERNON, OHIO.



CROSS COMPOUND CONDENSING FOR ELECTRIC RAILWAY WORK.

BUILDERS OF

CORLISS ENGINES

COMPOUND, CONDENSING AND HIGH PRESSURE,

From 50 to 3,000 H. P. with Girder or Semi-Tangye Frames.

NEW YORK OFFICE:

1022 Havemeyer Building, - - F. W. Iredell, Manager.

CHICAGO OFFICE:

Rookery Building, - Edward M. Hagar & Co., Managers.

CORNISH CYCLE ENGINES

work as silently when on condenser as when exhausting to the atmosphere.

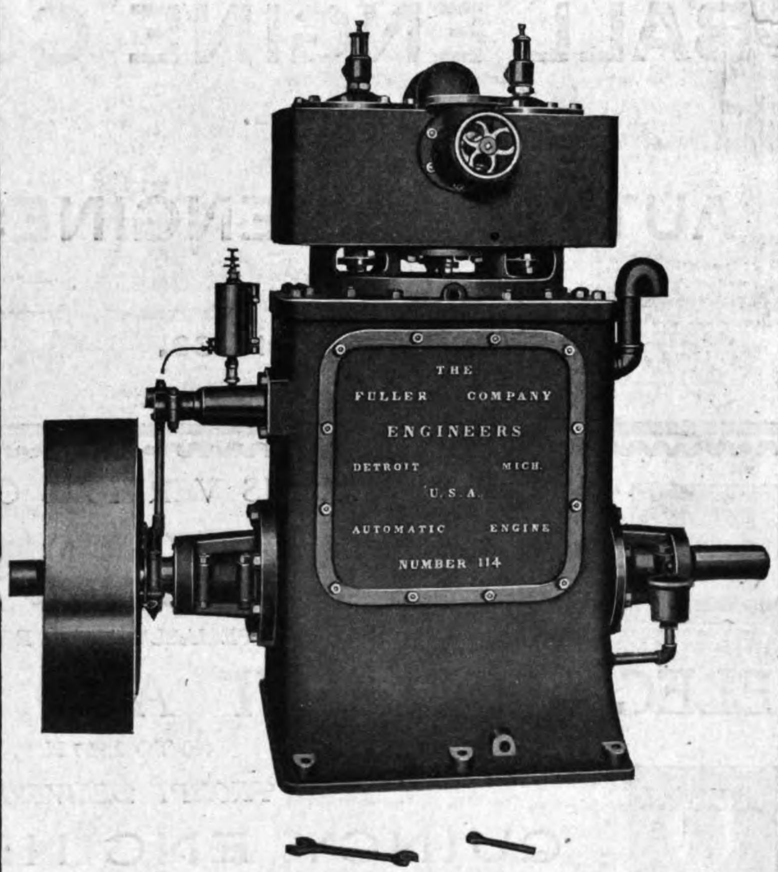
These engines are of the enclosed type, with splash lubrication, which offers so many advantages when run at the high speed required for dynamos, fan blowers, centrifugal pumps, &c.

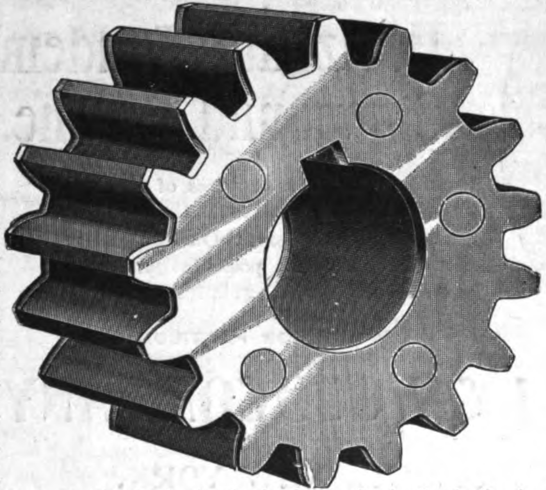
Especially suitable for hard work in dirty and dusty places, where ordinary engines would suffer in their working parts.

SIZES 7½ to 100 H. P.

Send for Catalogue and Bulletin C.

THE FULLER CO.
ENGINEERS
DETROIT, MICH.





CHICAGO RAWHIDE PINIONS
AND PINION BLANKS

WARRANTED BEST and MOST DURABLE MADE. For Noiseless Gearing.

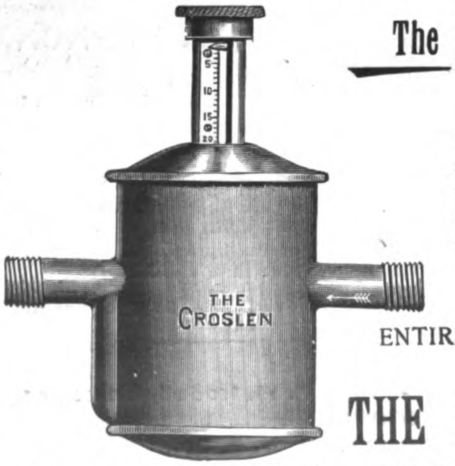
RAWHIDE DYNAMO BELTING. Strongest, most pliable and elastic. Great adhesive qualities. Smoothest running.

RAWHIDE TWIST.
RAWHIDE LACING.
RAWHIDE PACKING.

RAWHIDE BELL CORD.
Rawhide ROPE for Round Belting.
Transmission is superior to all others.

BOSTON, 200 Franklin St.
Agencies:
Philadelphia, London.

THE CHICAGO RAWHIDE MFG. CO.,
75 & 77 E. Ohio St., CHICAGO.



The Croslen Automatic Reducing Valve

will take compressed air, gas or fluid at any high pressure and reduce it automatically to any low pressure with absolute precision. It is absolutely free from leakage. Its delicacy of movement in responding to the slightest adjustment of the index, and the absolute simplicity of its construction commend it to all users of high pressure

STEAM, AIR AND WATER.

ENTIRELY AUTOMATIC IN ITS ACTION AND POSITIVE IN ITS REGULATION.

ADDRESS FOR CIRCULAR

THE CROSLEN MFG. CO., 119-121 LA SALLE STREET, CHICAGO.

THE BAUM SEPARATOR

Engineers
of Electric Lighting and
Power Plants

Who are desirous of
securing an
economical operation
of their
Steam Equipment,
will find it of advantage
to investigate our
Apparatus.

OUR CLAIMS AND GUARANTEE
WILL INTEREST AND CONVINCE YOU

Write for Booklet "S"

The Baum Separator Co.,
Reading, Pa. U.S.A.

Why?

Why is Warren's Pulley Cover used in 25 per cent. of the Central Electric Lighting, Power and Railroad Stations in America?

Because

It **insures uniform voltage** by reducing belt slipping to a minimum—allows belts to run slack, thus avoiding undue strain on belts and bearings.
It will pay you to investigate.
Write for particulars to-day.

THE WARREN COMPANY, Inc.
MANUFACTURERS
253 N. Franklin Street, CHICAGO, ILL.

LET US EXPLAIN!

"STOP YOUR LEAKS."

Mr. CENTRAL STATION MANAGER, do you realize that you have a very large leak in your steam pipe; that is, you are throwing away all of your exhaust steam which can be sold for three times what the fuel costs to produce it, thus securing your electric current free of expense at the station, and interest on the investment for steam heating plant; exhaust steam is as good for heating as live steam at the same pressure. If you have been allowing this exhaust steam to escape into the atmosphere, save it now by realizing $2,500.00 to $3,500.00 for every 100 H. P., by installing the Holly system of exhaust steam heating. It will pay you to investigate it. Write for pamphlet.

American District Steam Co.
LOCKPORT, N. Y.

Mention American Electrician.

THE STANDARD for RUBBER INSULATION.

Okonite Wires,
Manson Tape,

OKONITE
TRADE MARK.

Okonite Tape,
Candee Weather-proof Wires.

THE OKONITE CO., LTD.,
SOLE MANUFACTURERS,
Postal Telegraph Bldg., 253 BROADWAY, NEW YORK.

WILLARD L. CANDEE, H. DURANT CHEEVER, } Managers.
GEO. S. MANSON, Gen'l Supt.
W. H. HODGINS, Sec'y.

SILVER MEDAL PARIS EXPOSITION.

Recording Volt, Ampere and Watt Meters.

Make Continuous Record Day and Night.

Send for Catalogue. Recording Pressure Gauges. Recording Thermometers.

Every Instrument Fully Guaranteed.

THE BRISTOL CO., Waterbury, Conn.

CLAYTON & LAMBERT MFG. CO. No 1 DETROIT, MICH. U.S.A.

The No. 1 Torch

Was made as a companion to the No. 1 Fire Pot, and, like Eve, a part (not a rib) of the head of the family was taken and used in its make-up. It is fitted with a burner similar to that used on the No. 1 Fire Pot, but, like Eve, it is a finer piece of work, and much finer materials are used in its construction The No. 1 Torch is truly the finest torch on the American market, and she points with pride to her numerous daughters. We issue a little booklet that tells all about them; it is free and is worth dollars to you.

. . . . . .

$3.00 Net.

CLAYTON & LAMBERT MFG. CO., DETROIT, MICH.

NATIONAL ELECTRICAL CODE
STANDARD
SLOW-BURNING WEATHERPROOF

IXL WEATHERPROOF AND SLOW-BURNING WIRE

Send for Samples and Prices.

Collyer Insulated Wire Co., Pawtucket, R. I.

SHULTZ BELTING Co.
SHULTZ PATENT SABLE RAWHIDE BELTING.
SHULTZ PATENT WOVEN LEATHER LINK BELTING
GENUINE RAWHIDE LACE LEATHER. SHULTZ'S PATENT PULLEY COVER. BELT DRESSING AND BELT CEMENT.
DYNAMO BELTING
Send for Circulars.

ST. LOUIS, MO.

113 Liberty St., NEW YORK, N. Y.
184 Summer St., BOSTON, MASS.
116 No. Third St., PHILADELPHIA, PA.

DIAGRAMS OF Electrical Connections,

With Explanatory Test.

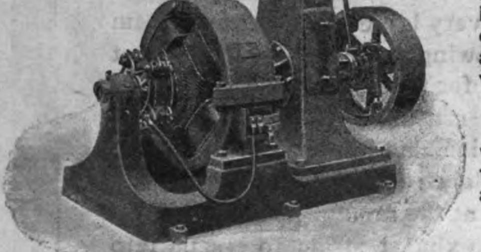
32 PAGES, 8½ IN. x 11¾ IN. 83 DIAGRAMS.

Direct and Alternating Current, Generator and Motor Connections—Series, Multiple, Three-Wire and Alternating Distribution—Compound Dynamo, Parallel and Equalizer Connections—Controller Connections—Arc Light Machine Regulator Connections, Etc., Etc.

PRICE 50 CENTS.

AMERICAN ELECTRICIAN COMPANY,
120 Liberty Street, New York.

CASE *AUTOMATIC HIGH-SPEED* STEAM ENGINES



Have a DOUBLE CUT-OFF which insures economy in consumption of steam, and absolutely no waste.

Our catalogue will tell you of their many other advantages.

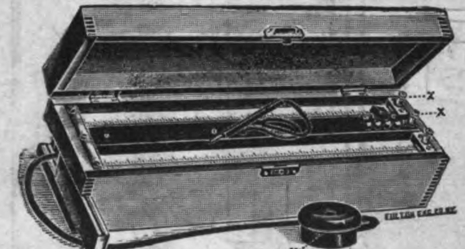
SEND FOR A COPY.

SIZES, 2 TO 25 H. P.

F. M. Pierce Engineering Co., 26 Cortland St., New York.

THE NEW BRITAIN MACHINE CO., New Britain, Conn., U. S. A.

THE BEST INSTRUMENT FOR MEASURING RESISTANCE.



DIRECT READING OHMMETER.

Voltmeters, Ammeters, Ohmmeters, Rheostat Brushes.

F. B. SAGE & BRO., 123 Liberty Street, New York City.
New York Agents of the WIRT ELECTRIC Co.

MORSE TWIST DRILL AND MACHINE CO., New Bedford, Mass., U. S. A.

MANUFACTURERS OF

Increase and Constant Angle Twist Drills,
Chucks, Reamers, Milling Cutters,
Taps, Dies and Machinists' Tools.

No. 109. BIT STOCK DRILLS FOR METAL OR WOOD.

Our Bit Stock Drills will fit any brace in the market, and will drill steel, iron, or other metals, as well as wood. They are not injured by contact with screws or nails, and will bore straight any kind of wood without splitting it.